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VOLUME 2

ARLINGTON CENTRAL SCHOOL DISTRICT

LAGRANGEVILLE, NEW YORK

PROJECT NO. 136396-24002.1

ADDITIONS AND ALTERATIONS TO LAGRANGE MIDDLE SCHOOL

DECEMBER 3, 2025

The engineer that has signed this document certifies that to the best of their knowledge, information and belief, the asbestos plans and specifications are in accordance with applicable requirements of the New York State Uniform Fire Prevention and Building Code, Construction Standards of the Commissioner of Education, New York State Department of Labor Part 56 of Title 12, and the United States Environmental Protection Agency Hazard Emergency Response ACT Regulations. Kevin C. Terry is accredited to the EPA and New York State under AHERA Regulations as an Asbestos Project Designer (Asbestos Handling Certificate Number 14-20336).

To the best of the Architect's knowledge, information and belief, the design of this project conforms to all applicable provisions of the New York State Uniform Fire Prevention and Building Code, the New York State Energy Conservation Construction Code, and the building standards of the New York State Education Department. It is a violation of the Education Law of the State of New York for any person to alter or modify this document in any way unless acting under the direction of a professional architect.

BID SET

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SECTION 11400 - FOOD SERVICE EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. All drawings and general provisions of the contract, including general and supplementary conditions, apply to the work of this section.

1.2 DESCRIPTION

A. Work Included:

1. The work of this section includes furnishing all labor, materials, transportation, appliances, and services necessary to complete all kitchen equipment and related work required by the drawings and/or herein specified, including, but not limited to, the following:
 - a. Furnishing, delivering, and setting in place of all food service equipment in spaces as shown and/or as hereinafter itemized.
 - b. All items of work reasonably inferred as necessary to complete the work of this section. Supply all necessary bolts, hangers, and brackets. Provide cut outs in equipment as necessary for electric, plumbing, or other utility lines required for hook up of the item.
 - *****c. Removal of all existing equipment to be reused from present locations to storage and installation of existing equipment in new locations after areas are ready.
 - *****d. Relocation of all equipment noted on drawings or in specifications. This is to be a phased project, and full cooperation and coordination must be maintained with the owner and other trades.
 - *****e. All existing equipment not to be reused (Including exhaust hood) shall be removed, and any items the owner does not wish to retain shall become the property of this contractor. Should the owner wish to retain an item, then this contractor shall move the item to a storage area as designated by the owner.

B. Related Work Described Elsewhere Performed by Others:

1. Supplying and installing all necessary drain traps, steam traps, vents, shut-offs, valves, pipe fittings, and/or other materials to complete final plumbing and electrical or steam connections between the rough-in and the connection or connections on each piece of equipment.
2. Ductwork and ductwork connections from hoods unless otherwise indicated.
3. Installing all drain fittings, tailpieces, faucets, operating switches, and/or starters.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications:

1. Firms regularly engaged in the manufacture of food service equipment of types, capacities, and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.

B. Installer's Qualifications:

1. Firm with at least three (3) years of successful installation experience on projects with food service equipment similar to that required for project.

C. Fabricator's Qualifications:

1. Where units require custom fabrication, provide units fabricated by a shop that is skilled with a minimum of five (5) years of experience in similar work. Fabricate all custom equipment items at same shop. Where units cannot be fully shop-fabricated, complete fabrication work at project site. Fabricator shall be subject to the approval of the food service equipment consultant.

D. Codes and Standards:

1. All food service equipment shall be provided, fabricated, and installed in compliance with the following, where such standards have been set: NSF, AGA, UL, ASME, NEMA, NFPA, State Department of Health regulations, and other applicable State, County, and Local governing laws and ordinances.
2. Nothing in the contract documents shall be construed to conflict with any local or state laws or regulations governing the installation of any part of the work to be performed under this contract, and all requirements shall be in accordance therewith, without additional cost to the owner. Installation of equipment must comply with applicable regulations of the local health department.

1.4 SUBSTITUTIONS

- A. The materials, products, and equipment items or types shown on the Contract Drawings or listed in this Specification establish the standard of performance, quality, function, dimension, and appearance required. Products, materials, and equipment items not listed herein or on the Contract Drawings but which achieve identical or superior performance to those specified in all aspects but particularly with respect to gender, configuration, and finish are not excluded provided the established criteria described and required is met and such components are shown to be true equals to the satisfaction of the Owner, Architect, Engineer, and Food Facilities Consultant.
- B. The bidder may base his bid or proposal on the use of one or more of these items or an equivalent substitution. If substitutions are proposed, the bid must contain a list of all proposed substitutions. Also, each bidder shall list by Specification Sections, all materials, products, or equipment he proposes to offer as possible substitutions for specified items, together with all information on the product required for a complete review.
- C. No additional substitutions will be considered unless substitution is required due to a specified material, product, or equipment being removed from or made unavailable in the marketplace. Upon such circumstances, additional substitutions will be considered by the Architect, but only at no charge to or at a credit to the Contract amount, and at no change in completion time.
- D. A request for substitution constitutes a representation that the submitter:
1. Will coordinate installation and make changes to other work, which may be required for the work to be completed with no additional cost to the Owner or to other Contractors.

2. Waives claims for additional costs or time extension, which may subsequently become apparent.
3. Will reimburse the Owner, Architect/Engineer, and Food Facilities Consultant for review or redesign services associated with reapproval by authorities.

1.5 SUBMITTALS

A. Shop Drawings:

1. Within 45 days after award of contract, and before any kitchen equipment is delivered to the job site, submit complete shop drawings to the architect for approval. Show all conditions where equipment will interface with the work of other trades.

B. Details:

1. Rough-in drawings, showing detailed dimensions of all utility lines for all equipment shall be furnished, drawn to a scale of not less than 1/4" to 1'-0". Rough-in drawings shall contain the following *individual* drawings:
 - a. A layout drawing showing all food service and related equipment with all items properly marked as to item number.
 - b. An individual mechanical layout drawing for each of the mechanical trades, i.e.: Electrical, Plumbing and Heating/Ventilating.
 - c. A drawing showing any required recesses in the floor for walk-ins etc.
2. Furnish shop drawings with details showing all dimensions and details of construction, installation, and related work. Shop drawings of fabricated equipment shall be drawn to a scale of not less than 3/4" to 1'-0".
3. Manufacturer's names, cuts, descriptive data, rated capacities, and other information necessary for approval of standard manufactured articles and equipment shall be submitted to architect for written approval before ordering or fabricating. Catalog cuts shall be submitted in bound booklet form with each item (including existing and spare numbers) having its own title sheet before the catalog cut. The title sheet shall contain the item number, quantity, make, model and any and all accessories provided.
4. Submittals shall be provided electronically. If submitting hard copies, submit eight (8) copies of all drawings and catalog cuts (in booklet form) to the architect's office for approval and distribution. The review of any and all drawings and catalog cuts will not relieve the contractor of any responsibility for providing the items, etc. as called for in the specifications.

C. Samples:

1. Samples shall be provided as requested by the architect.

1.6 PRODUCT DELIVERY, HANDLING, AND STORAGE

- A. Equipment shall be delivered when required and shall be safely stored on the premises and protected against damage.
- B. Deliver all equipment to the job promptly and in such time as not to delay the work of other trades. Cooperate with all other trades in the proper installation of this equipment.

Set level, plumb, and true and anchor to floor, walls, or ceiling as required. Leave all equipment ready to receive final plumbing, electric, and ventilation connections, which shall be provided under respective sections.

- C. No deliveries shall be made unless this contractor's representative is on the job site to receive same and see that it is properly stored and protected. Neither the owner, construction personnel or architect will receive any equipment or be in any way responsible for same.
- D. All responsibilities shall lie with the contractor for damage incurred, loss of materials, and loss of items while in the building or during transportation. Any articles found damaged shall be immediately replaced or repaired at this contractor's expense to the satisfaction of the architect.

1.7 JOB CONDITIONS

- A. Inspect surfaces to receive work of this section. Report any unsatisfactory conditions to the architect. Proceeding with the work shall be evidence of acceptance of job conditions.
- B. Take field measurements to assure accurate fit of all food service equipment.
- C. Check electrical characteristics and water, steam, and gas pressures. Provide pressure regulating valves where required for proper operation of equipment.

1.8 GUARANTEES

- A. This contractor shall fully guarantee all work and materials for a period of one year from date of acceptance. Should any defect in work or materials, not due to ordinary use, appear in the above-mentioned time, this contractor agrees to repair or replace the same without cost to the owner, as directed, immediately upon written notice of such defect from the owner or owner's previously identified agent. All refrigerated items shall have an additional four (4) year warranty on all compressors.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Unless otherwise called for under the individual items of equipment set forth hereinafter or shown on the details, the general construction called for under each specific material and all detail drawings shall apply to all fabricated equipment.

2.2 METALS

- A. Stainless steel shall be AISI type 304, with not less than a #4 mill finish on all exposed surfaces. All welding wire used shall be type 308L. All sheets shall be free of buckles, warps, and surface imperfections.
- B. Galvanized iron shall be 1½" x 1½" x ⅛". Where galvanized iron has been welded, all seams shall be cleaned and scale removed and finished with a prime coat of aluminum paint. All galvanize shall be 8% copper bearing alloy with an approved hot dip pure zinc galvanizing.
- C. A white metal (commercially known as nickel silver) casting is intended. Such metal to be of corrosion resistant quality and shall contain not less than 30% nickel. All castings

shall be rough ground, polished, and buffed to a bright luster, free from pits, cold runs, checks, burrs, or other surface imperfections.

- D. Stainless steel pipe and tubing shall be seamless of gauge specified and of true roundness. All tubing, where exposed to view, shall be given a final grind of not less than 180 grit emery.
- E. All angles, bands, channels, or other structural shapes used for framing shall be of domestic manufacture, uniform and ductile in quality. Where such sections are specified as galvanized, they shall be galvanized by the hot dip process with all excess spelter removed, and be smooth and free from cold runs, blisters, and uncoated or scaly patches.

2.3 HARDWARE

- A. Where equipment is provided with handles, knobs, hinges, brackets, or other miscellaneous hardware, all shall be of either white metal or stainless steel of metallurgical composition previously specified.

2.4 FABRICATION

A. Welding:

1. All welding of stainless steel shall be done by the electric heliarc process. Carbon arc will not be permitted. All welding of galvanized iron shall be done by the electric fusion-metal-arc method. All welding shall be done in a thorough manner with welding rod as specified hereinbefore of stainless steel or of same composition as sheets or parts welded. Welds shall be complete welds, strong and ductile with excess metal ground off and joints finished smooth to match adjoining surfaces. Welds are to be free of mechanical imperfections such as gas holes, pits, runs, cracks, etc., and shall have same color as adjoining sheet surfaces. All joints in tops of fixtures, tables, drainboards, exposed shelving, sinks, fronts and ends of cabinets exposed to view, etc., shall be completely welded. Butt welds made with solder and finished by grinding will not be acceptable.
2. All welded joints shall be homogeneous with the sheet metal itself. Where sheet sizes necessitate a joint, such joints shall be welded. Tops of fixtures shall be fabricated in the factory with welded joints to reduce field joints to a minimum. Wherever welds occur on surfaces not finished by grinding and polishing, such welds, and the accompanying discoloration, shall be suitably coated in the factory by means of metallic base paint to prevent the possibility of progressive corrosion at such points. All field joints shall be welded, ground smooth, and polished.

B. Soldering:

1. Soldering, where required and/or permitted, shall be done with a solder consisting of no more lead than is allowable by code. Stainless steel requiring soldering shall be first thoroughly cleaned of surface oxides and shall then have applied a suitable stainless steel soldering flux. After the soldering has been completed, excess of remaining flux shall be removed and the entire soldered joint cleaned with liquid alkaline to prevent any attack of the stainless steel by soldering flux.

C. Grinding, Polishing, and Finishing:

1. All exposed welded joints shall be suitably ground flush with the adjoining material and neatly finished to harmonize therewith. Wherever material has been sunken or depressed by a welding operation, such depressions shall be suitably hammered and peened flush with the adjoining surfaces, and, if necessary, ground to eliminate low spots. All ground surfaces consistent with good workmanship. Care shall be exercised in all grinding operations to avoid excessive heating of the metal and metal discoloration. In all cases, the grain of rough grinding shall be removed by a successive finer polishing operation. The texture of the final polishing operations shall be uniform and smooth, consistent with reasonable care and good workmanship. The finish of all equipment shall be of a high grade.
2. Butt joints and contact joints, wherever they occur, shall be close fitting. Wherever brake bends occur, they shall be free of undue extrudence and shall not be flaky, scaly, or cracked in appearance, and where such brake work does mar the uniform appearance of the surface of the material, all such marks shall be removed by suitable grinding, polishing, and finishing. Wherever sheared edges occur, they shall be free from burrs, fins, or irregular projections and shall be finished to obviate all danger of cutting or laceration when the hand is drawn over such sheared edges. Where miters or bullnosed corners occur, they shall be neatly finished with the under edge of material neatly ground to a uniform condition, and in no case are overlapping materials to be acceptable.
3. All exposed surfaces shall have a #4 ground finish, except trim, which is to be of a more highly polished satin finish. Where specified, all cabinets, doors, and shelves, whether inside or outside of cabinets, and wherever exposed are to be #4 finish. This applies to inside finish of any cabinet having doors or otherwise. An exposed surface shall be interpreted as meaning an inside surface exposed to view when a sliding or swinging door is opened. The underside of shelf need not be #4 finish but such finish shall be at least equal to #80 ground finish. The tops of tables, sinks, dishtables, where manufacturing operations and welding disturb the original #4 finish, shall be finished in a satin finish.
4. Deliver all stainless steel equipment to the job covered with a protective paper coating. Remove this coating when directed by the architect and restore any surfaces that are scratched or marred to their original finish, and to the approval of the architect.

D. Stainless Steel Tops:

1. Where specified, all tops shall be constructed of not less than 14 gauge stainless steel, with all edges rounded without burrs or excess metal. All edges shall be rolled on 180° roll 1½" in diameter on all exposed sides. Where tabletops are placed against wall, refrigerators, cabinets, etc., they shall be turned up on the back and/or sides approximately 6" and returned 2" on a 45° break, with all exposed ends closed, welded, ground, and polished. All corners shall be reinforced on the underside with 1" x 4" x 1" stainless steel channels of not less than 14 gauge stainless steel. These channels shall be spaced not more than 30" apart in any direction and shall give full perimeter as well as interior support.
2. All equipment shall be set in place either 3" away from wall or sealed to the wall surface on all edges using food grade silicone.

E. Stainless Steel Legs:

1. All legs shall be constructed of not less than 1½" OD stainless steel seamless tubing, having a wall thickness of not less than 16 gauge. Stainless steel shall be of type as hereinbefore specified. Legs shall be spaced no more than 6'-0" on center. All legs shall be polished to a uniform finish.
2. Leg mounting shall be inserted into 16 gauge stainless steel conical gussets type 483-58 as manufactured by Standard Keil. Gussets shall be welded around entire circumference continuous, sealing gusset against underbracing channel.
3. All legs shall be provided with stainless steel adjustable feet type #A10-0851 as manufactured by Component Hardware, complete with #A10-0010 lock ring. Legs supporting sink units shall be fitted with stainless steel flanged feet type #A10-0854 with #A10-0010 lock ring as manufactured by Component Hardware.
4. Leg crossbracing, where required, shall be constructed of not less than 1" OD stainless steel seamless tubing as previously specified. All crossbracing shall run horizontal and level between legs and forming a box type framing between all legs, approximately 12" above the floor. Crossbracing shall be formed to and fully welded to the legs, with all welds ground and polished. Where one side of the boxed unit bracing is omitted to provide space for carts, bins, etc., the adjacent leg shall be fully braced in the prescribed manner.

F. Undershelving:

1. Undershelving shall be constructed of not less than 16 gauge stainless steel. Each undershelf shall be the full depth of the individual unit. Front edges shall be turned down 1½" and returned ½", sides and rear to be turned up 2". Corners shall be notched at legs and welded, ground, and polished to same. Undershelves, where required, shall be provided with pipe slots of suitable size to accommodate necessary service lines. Slots shall be turned up on all sides to eliminate cutting or defacing of equipment on the job.

G. Drawers:

1. Unless otherwise noted, drawers shall be 20" x 20" x 5" die-stamped 20 gauge stainless steel having all inside corners coved. Drawer body shall be lift-out type. Front of drawers shall be double pan 16 gauge stainless steel exterior and 20 gauge stainless steel interior. Drawer shall be suspended by ball bearing heavy-duty extension slides, Model #9190 as manufactured by Standard Keil Hardware. The drawer slides shall be attached to channel bracing under the tabletop. Drawer pulls shall be Standard Keil #SS-12100.

H. Plumbing Fixtures:

1. Faucets:
 - a. Furnish faucets on sinks, steamtables, bain maries, water stations and other equipment as shown on plans, details and specifications. Furnish water saving devices where required by local codes. All faucets intended to dispense water for human consumption shall be manufactured of materials that contain no lead intentionally added to the product. Finish shall be polished stainless steel. All faucets specified to have standard lever type handle with internationally coded handle identification buttons (hot and cold) and ADA easy turn stems. All faucets shall have internal

stainless steel seats and two part swivel stems. All plumbing fixtures shall be ANSI/NSF 61 sec. 9 certified, CSA Certified, California AB 1953 Compliant, Vermont S152 Compliant, and EPA 2005 compliant.

2. Pre Rinse Units:

- a. Shall have integral spring loaded check stems to prevent cross flow, stainless steel seats in control valve, hose equipped with three ply hydraulic type hose liner, spray valves shall be 1.15 GPM for water conservation, be fitted with backflow prevention device (where required), and furnished complete with nipples, lock nuts, washers for secure and proper installation.

3. Waste Valves:

- a. Each sink compartment shall be provided with one ball valve type waste valve. Waste valve shall have a stainless steel rotating ball, two Teflon seals, 1½" and 2" outlet threads. Unless otherwise specified all waste valves shall have overflow tubes and fittings.

4. All faucets, pre rinse units and fixture brand shall be consistent throughout project (except where specified otherwise) and shall be as manufactured by Fisher Manufacturing Company, or **equal** by T&S Brass and Bronze or Dormont.

I. Sinks:

1. Where specified, there shall be single or multiple compartment sinks of size specified or shown on drawings. All sinks to be made entirely of 14 gauge stainless steel; all lengths, widths, and depths as hereinafter specified or as shown on drawings. Backsplash shall be drilled as required to accommodate faucets as specified and shown on drawings. Sink shall be of welded, seamless construction with all joints, crevices, etc., eliminated and all traces of welding removed. Corners, both horizontal and vertical, shall be rounded to 1" radius with intersections meeting in spherical coves. All edges shall be integrally rolled on 1½" diameter to a 180° closure with front corners fully rounded on outside of roll. Both rear corners to be curved and welded into the upturned splash. Bottoms shall be scored towards outlets to permit complete drainage. Die-stamped recess shall be formed in bottom of each compartment to accommodate waste outlet. In multiple compartment sinks, partitions shall be of coved corner construction consisting of two thicknesses of 14 gauge stainless steel formed from one sheet. Top edge of partition to be rounded on ½" radius, and all corners, where partitions meet the sides, shall be coved. Where partitions occur, there shall be no beads or straps on the outside of sink. Front, bottom, and back of sink shall be constructed of one sheet of metal in order to eliminate crevices between each compartment.

J. Drainboards:

1. Where called for, drainboards shall be of same gauge and material as sink and shall be full width of sink with exposed ends bullnosed. Backs shall be provided with high backsplashes to match backsplashes of sink. The front and ends shall be turned up 3", rolled and made continuous with roll of sink. The drainboards shall be pitched to drain to sink, welded, ground, and polished smooth to make entire unit into one piece. All welding shall be integral, and tack welding or bolted construction will not be acceptable. Support drainboards up to 36" in length by 1" diameter stainless steel tube welded to underside of drainboard and leg gusset.

Support drainboards 36" and longer with legs. Cove horizontal and vertical corners with not less than $\frac{3}{4}$ " radius.

K. Dishtables:

1. Fabricate dishtables of 14 gauge stainless steel, with exposed edges formed into $1\frac{1}{2}$ " x 190° rolled rim approximately 3" high. Provide built-in pitch of $\frac{1}{4}$ " minimum. Provide 10" high rim of type as indicated in the specifications. Cove horizontal and vertical corners with not less than $\frac{3}{4}$ " radius.

L. Framing:

1. Mount tops on $1\frac{1}{2}$ " x $1\frac{1}{2}$ " x $\frac{1}{8}$ " galvanized angle iron or 4" wide x 12 gauge galvanized channels. Mount dishtables and drainboards on 4" wide x 14 gauge stainless steel channels.
2. Run framework around entire perimeter of unit, and crossbrace on 30" centers. For dishtables and drainboards, run framing from front to back at each leg location, and run additional channel lengthwise, located at center of table width and welded to leg channels. Fasten framing to underside of top surfaces with $\frac{1}{4}$ " studs welded at approximately 12" centers. Provide each stud with suitable chrome-plated lockwashers and capnuts and make stud lengths such that capnuts can be made up tight bringing top down snugly to framing.

M. Enclosed Cabinets:

1. Enclosed cabinets shall be constructed of angle iron frame as hereinbefore specified. Exposed angle shall be $1\frac{1}{2}$ " x $1\frac{1}{2}$ " x $\frac{1}{8}$ " stainless steel and concealed angle of galvanized iron. Frame construction shall provide a complete box-like welded frame with tops and fronts reinforced with angle iron on approximately 30" centers. Exterior of cabinets shall be 18 gauge stainless steel with openings, door frames, drawer openings, etc., having butt welded flush joints. Compressor compartments, refrigerated compartments, and open shelving areas shall have double pan bulkheads with full insulation where required. Where cold pans and other inserts are installed in a cabinet base, an apron shall be provided the full depth of the insert and shall be of the same material as the body. Openings shall be formed in on all sides and reinforced where necessary.

N. Doors:

1. Sliding doors shall be constructed of 18 gauge stainless steel exterior and 20 gauge stainless steel interior, all double pan construction with all corners welded, ground, and polished. Door shall be suspended on overhead track Model #550 as manufactured by Standard Keil. Doors shall be retained at the bottom with a depressing pin Model #1906 as manufactured by Standard Keil. All doors shall be removable and fitted with recessed stainless steel pulls.
2. Hinged doors shall be of same construction as for sliding doors except they shall be mounted on full-length stainless steel continuous type hinges. Doors shall be fitted with recessed stainless steel pulls, permanent magnetic catches, and door locks where indicated. Door face shall be flush with cabinet body.

O. Shelves:

1. Cabinet shelves shall be of 16 gauge stainless steel all welded construction turned up 2" on back and ends and down on front. Bottom shelf shall be

extended forward and be turned down at front flush with cabinet body. Fixed intermediate shelves shall be welded to 14 gauge stainless steel brackets, which in turn shall be welded cabinet interior in such a manner as to provide a 1" space between shelf and cabinet at back and ends. Removable shelves shall be set on full perimeter 14 gauge stainless steel channeling.

P. Sinks in Worktops:

1. Sinks incorporated into work surfaces shall be as hereinbefore specified, except rolls, inversions, and backsplashes shall be omitted and the bowl shall be completely welded integrally and flush with the work surface. Each sink shall be provided with drain and waste fitting as hereinbefore specified.

Q. Cold Pans:

1. Fabricate cold pans from 14 gauge stainless steel lining and 20 gauge stainless steel casing. Cove interior horizontal and vertical corners. Insulate sides, ends, and bottom with material thermally equal to 2" thickness of fiberglass. Sweat ½" diameter copper cooling coils to underside of cold pan, and seal in thermostatic material. Turn down countertop 1" into pan. Install completely concealed 1" wide plastic breaker strip. Install 1" chrome plated drain with plug. Provide ½" high false bottom of 14 gauge perforated stainless steel in removable sections.

PART 3 - EXECUTION

3.1 SURFACE CONDITIONS

- A. Prior to installation, verify that kitchen equipment may be installed in accordance with the manufacturer's recommendations; notify the architect in the event of a discrepancy. Do not proceed until all such discrepancies have been fully resolved unless directed to do so.

3.2 INSTALLATION

A. Procedure:

1. Move equipment into location specified and properly install all equipment per approved shop drawings and in strict accordance with the manufacturer's correct recommendations.
2. Coordinate with electrical and mechanical contractors for their final connection to services required. All final plumbing and electrical connections shall be by electrical and mechanical contractors.
3. Inspect all equipment for compliance and test by cycling equipment through various stages to verify proper operation.

3.3 TESTING AND OPERATING INSTRUCTION

- A. After completion of installation, the manufacturer's representative shall test all equipment and instruct kitchen personnel in the use and care of all items of equipment. A representative from this contractor shall be present at time of demonstration(s).

- B. Provide two (2) sets of repair and maintenance manuals for each item of mechanically operated equipment. All brochures shall be bound in booklet form. Also include a list of all service agencies with address and telephone numbers.

3.4 ADJUSTMENT AND CLEANING

- A. Upon completion of installation and hook-up of equipment, put each item through a complete operating cycle and verify that all equipment is properly installed and properly operating; verify that all trim is in place; adjust all components as necessary to ensure continued proper operation; remove all labels and protective paper from equipment and remove all packing materials from the job site. Thoroughly clean all equipment.

3.5 PUNCH LIST

- A. A representative of this contractor shall be present at time of final inspection(s).

PART 4 - LIST OF EQUIPMENT

4.1 ITEM 101 - MOBILE SHELVING UNITS - FOUR (4) REQUIRED

- A. Mobile shelving units shall be as manufactured by Eagle, Model #QPF-QAE-GL.
- B. Mobile shelving units shall be provided with EagleGard finish, four shelves high with 74" posts. Shelves shall be 24" x 48", louvered. Each unit shall be provided with four (4) #CSPB5-300 casters.

4.2 ITEM 102 - ICE MACHINE - ONE (1) REQUIRED

- A. Ice machine shall be as manufactured by Follett, Model #D414AT.
- B. Ice machine shall be provided with all standard equipment, plus the following:
 - 1. #425-30 Ice Bin
 - 2. Water Filtration System
 - 3. One (1) Carton of 6 Primary Cartridges
 - 4. One (1) Carton of 12 Pre-Filter Cartridges
 - 5. One (1) Carton of (6) 8 oz Bottles SafeCLEAN Ice Machine Cleaner
 - 7. One (1) Carton of (12) 16 oz Bottles Nu-Calgon Ice Machine Sanitizer
 - 8. Ice Shovel
 - 9. Saf-T-Scoop
 - 10. Dormont Swirl Hose Assembly with Disconnect

4.3 ITEM 103 - ANGLE RACKS - TEN (10) REQUIRED

- A. Angle racks shall be as manufactured by F.W.E., Model #OTR-UA-12.
- B. Angle racks shall be provided with all standard equipment, plus the following:
 - 1. Vertical Bumpers
 - 2. Casters with Brakes

4.4 ITEM 104 - STORAGE SHELVING - ONE (1) LOT

- A. Storage shelving shall be as manufactured by Eagle, Model #QPF-QAE-GL.

- B. Storage shelving shall be provided with EagleGard finish, five (5) shelves high with 86" posts. Storage shelving shall be provided with louvered shelves in sizes as shown on drawing.
- C. It shall be the responsibility of this contractor to verify and adjust shelving sizes to insure proper fit.

4.5 ITEM 105 - STORAGE DUNNAGE - ONE (1) LOT

- A. Storage dunnage shall be as manufactured by Eagle, Model #QP-DRE-GL.
- B. Storage dunnage shall be provided with EagleGard finish with louvered shelves. Storage dunnage shall be provided with all standard equipment in sizes as shown on drawing.
- C. It shall be the responsibility of this contractor to verify and adjust dunnage rack sizes to insure proper fit.

4.6 ITEM 106 - CAN RACK - ONE (1) REQUIRED

- A. Can rack shall be as manufactured by Piper, Model #CSR-FF-156.
- B. Can rack shall be provided with all standard equipment, plus the following:
 - 1. Casters with Brakes
 - 2. Rotating Bumpers

4.7 ITEM 107 - JANITOR'S CABINET - ONE (1) REQUIRED

- A. Janitor's cabinet shall be as manufactured by Advance/Tabco, Model #9-OPC-84DL-300.
- B. Janitor's cabinet shall be provided with all standard equipment, plus the following:
 - 1. #SU-27 Door Lock
 - 2. #K-94-SHELF Fixed Mid Shelf
 - 3. #K-94-BACK-300 Stainless Steel Back Panel
 - 4. #K-472 Faucet Holes
 - 5. #K-240 Service Faucet

4.8 ITEM 108 - UTILITY CARTS - TEN (10) REQUIRED

- A. Utility carts shall be as manufactured by Piper, Model #1-UCS-3.
- B. Utility carts shall be provided with all standard equipment, plus the following:
 - 1. 14 Ga. Stainless Steel Shelves
 - 2. Casters with Brakes

4.9 ITEM 109 - MIXER - ONE (1) - EXISTING/RELOCATE

4.10 ITEM 110 - 20 QT. MIXER - ONE (1) - EXISTING/RELOCATE

4.11 ITEM 111 - MIXER STAND - ONE (1) REQUIRED

- A. Mixer stand shall be as manufactured by F.W.E, Model #OTR-2228-24-FE.
- B. Mixer stand shall be provided with all standard equipment, plus the following:

1. Corner Bumpers
2. Floor Lock
3. Utensil Rack

4.12 ITEM 112 - BAKER'S TABLE - ONE (1) REQUIRED

- A. Baker's table shall be custom built, approximately 5'-6" x 30" x 34" high to working surface.
- B. Baker's table shall be provided with the following:
 1. 8" Backsplash Rear and Ends, Enclosed Where Exposed
 2. Crossbracing
 3. Tier of Three (3) Drawers
 4. Overshelf Per Detail

4.13 ITEM 113 - INGREDIENT BINS - TWO (2) REQUIRED

- A. Ingredient bins shall be as manufactured by Piper, Model #47-150.
- B. Ingredient bins shall be provided with all standard equipment.

4.14 ITEM 114 - TRASH CANS - ONE (1) LOT - NIC/BY OWNER

4.15 ITEM 115 - EXHAUST HOOD - ONE (1) REQUIRED

- A. Exhaust hood shall be as manufactured by Halton, Model #KVE, approximately.
- B. Exhaust hood shall be provided with the following:
 1. Make-Up Air Fan
 2. Exhaust Fan
 3. MARVEL System

4.16 ITEM 116 - FIRE SUPPRESSION SYSTEM - ONE (1) REQUIRED

- A. Fire suppression system shall be as manufactured by Ansul, Model #R-102.
- B. Fire suppression system shall cover the hood, duct, and any necessary appliances below. Provide all necessary electrical contacts and gas valves as may be required. The fire protection system shall comply to both NFPA96 and NFPA17 requirements.
- C. All components to be new from manufacturer, not recertified or remanufactured as new.
- D. Furnish a complete wet chemical fire suppression system model R102 as manufactured by "Ansul" or equal in compliance with UL 300 standards. The system shall include factory prepiped, all permits and test as required by the authority having jurisdiction.
- E. Automatic actuation shall be by means of fusible with no visible conduit.
- F. System shall be furnished and installed by an Ansul certified distributor in accordance with manufacturer's instructions and the authority having jurisdiction.
- G. Microswitches shall be furnished as part of the fire protection system for tie in of building alarm and for make-up air/fire/fuel shut down.

- H. All access openings, holes, sleeves, chases, etc., in building structure necessary to permit piping and control tubing to be run between system unit, ventilator and duct work are to be provided by the General Contractor.
- I. The Building Alarm System Contractor is to furnish a control relay to detect operation of the system by connection to the microswitches supplied. The Electrical Contractor is to furnish shunt trip breakers as required and install all wiring required for the system specified.
- J. All exposed piping and nozzles of fire protection system shall be chrome or Stainless steel sleeved.
- K. All horizontal piping is to be done on the top of the ventilator unless otherwise specified.

4.17 ITEM 117 - FRYER SYSTEM - ONE (1) LOT

- A. Fryer system shall be as manufactured by Pitco, Model #SE14X-2FD.
- B. Fryer system shall be provided with all standard equipment, plus the following:
 - 1. Digital Controls
 - 2. Stainless Steel Splash Guard
 - 3. Crumb Scoop
 - 4. Skimmer
 - 5. Tank Covers
 - 6. Filter Drawer
 - 7. One (1) Case Filter Powder
 - 8. One (1) Box Filter Paper
 - 9. Casters with Brakes
 - 10. T&S Posi-Set

4.18 ITEM 118 - STEAMER - ONE (1) REQUIRED

- A. Steamer shall be as manufactured by Accutemp, Model #E62081E060 DBL.
- B. Steamer shall be provided with all standard equipment, plus the following:
 - 1. #SNH-21-01 Support Stand with Casters
 - 2. T&S Posi-Set

4.19 ITEM 119 - RANGE - ONE (1) REQUIRED

- A. Range shall be as manufactured by Imperial, Model #IR-6-EW.
- B. Range shall be provided with all standard equipment, plus the following:
 - 1. Casters with Brakes
 - 2. T&S Posi-Set

4.20 ITEM 120 - POT FILLER - ONE (1) REQUIRED

- A. Pot filler shall be as manufactured by T&S, Model #B-0610-CR.
- B. Pot filler shall be provided with all standard equipment.

4.21 ITEM 121 - CONVECTION OVENS - THREE (3) REQUIRED

- A. Convection ovens shall be as manufactured by Blodgett, Model #MARK V Double.
- B. Convection ovens shall be provided with all standard equipment, plus the following:
 - 1. One (1) Extra Oven Rack Per Deck
 - 2. Casters with Brakes
 - 3. T&S Posi-Set

4.22 ITEM 122 - SPARE NUMBER

4.23 ITEM 123 - SPARE NUMBER

4.24 ITEM 124 - COOK'S COUNTER - ONE (1) REQUIRED

- A. Cook's counter shall be custom built, approximately 12'-3" x 30" x 34" high to working surface.
- B. Cook's counter shall be provided with the following:
 - 1. One (1) 20" x 20" Sink Compartment
 - 2. 8" Backsplash
 - 3. Crossbracing/Undershelf
 - 4. Flange Feet
 - 5. Overshelf with Pot Rack Per Detail #12.4
 - 6. Two (2) Drawers with Locks
 - 7. One (1) T&S #B-2342/B-0230-KIT/B-WH4 Faucet with Aerator
 - 8. One (1) T&S #B-3972-01 Leverwaste with Overflow

4.25 ITEM 125 - WORKTABLE - ONE (1) REQUIRED

- A. Worktable shall be custom built, approximately 7'-0" x 30" x 34" high to working surface.
- B. Worktable shall be provided with all standard equipment, plus the following:
 - 1. 6" Backsplash
 - 2. Undershelf
 - 3. Two (2) Drawers with Locks
 - 4. Cutting Boards Under Drawers

4.26 ITEM 126 - MICROWAVE OVEN - ONE (1) REQUIRED

- A. Microwave oven shall be as manufactured by Winco, Model #EMW-1000-ST.
- B. Microwave oven shall be provided with all standard equipment.

4.27 ITEM 127 - PREP SINK - ONE (1) REQUIRED

- A. Prep sink shall be custom built, approximately 7'-2" x 30" x 34" high to working surface.
- B. Prep sink shall be provided with all standard equipment, plus the following:
 - 1. 10" Backsplash
 - 2. Two (2) 18" x 24" Sink Compartments
 - 3. Crossbracing

4. Flange Feet
5. One (1) T&S #B-0133-A12B-KIT Pre-Rinse with Bracket and Add-On Faucet
6. Two (2) T&S #B3972-01 Leverwastes with Overflow

4.28 ITEM 128 - WALK-IN COOLER/FREEZER - ONE (1) REQUIRED

- A. Walk-in cooler/freezer shall be as manufactured by Bally, approximately 21'-2" x 17'-4" x 8'-6" high.
- B. Walk-in cooler/freezer shall be provided with the following:
 1. Aluminum In and Out
 2. White Aluminum Ceiling
 3. Aluminum Diamond Plate Floor with Stainless Steel Exterior
 4. Aluminum Diamond Plate Kickplates, 36" High
 5. High-Low Temperature Alarm
 6. Two (2) LED Light Fixtures, Each Compartment
 7. Foot Treadle
 8. Bumper Rails on Exposed Areas
 9. Trim Strips
 10. #SLC07-1036AA Berner Air Doors with Walk-In Cooler Kit

4.29 ITEM 129 - REFRIGERATION SYSTEMS - ONE (1) LOT

- A. Refrigeration systems shall be provided by Bally, sized as follows:
 1. Cooler - Sized for 35°
 2. Freezer - Sized for -10°
- B. Refrigeration systems shall consist of hermetic or semi-hermetic type condensing unit. Refrigerant used shall be of the latest type available and shall meet all codes and governmental requirements. All condensing units shall be factory assembled using UL listed or recognized components. Evaporators shall be forced air type, designed for ceiling installation. Freezer evaporators shall come with automatic electric defrost system with time clock, fan delay thermostat, heaters and heated drain pan. Evaporators shall be UL listed or recognized. Systems shall be installed with nylon bolts provided.
- C. The condensers shall be located on the roof of the building above. Provide any and all necessary outdoor controls and weatherproof housings as may be required.
- D. It shall be the responsibility of this contractor to completely install all refrigeration piping and controls (including interconnection of all electric) and drain lines from coils in rigid copper to the floor drain, leaving the unit ready for final connections only by other trades. Drain line heater for freezer shall be supplied and installed by this contractor.

4.30 ITEM 130 - FREEZER DUNNAGE - TWO (2) REQUIRED

- A. Freezer dunnage shall be as manufactured by Eagle, Model #QP-DRE-GL.
- B. Freezer dunnage shall be provided with EagleGard finish with louvered shelves. Freezer dunnage shall be provided with all standard equipment in sizes as shown on drawing.
- C. It shall be the responsibility of this contractor to verify and adjust dunnage rack sizes to insure proper fit.

4.31 ITEM 131 - FREEZER SHELVING - ONE (1) LOT

- A. Freezer shelving shall be as manufactured by Eagle, Model #QPF-QAE-GL.
- B. Freezer shelving shall be provided with EagleGard finish, four (4) shelves high with 74" posts. Freezer shelving shall be provided with louvered shelves in sizes as shown on drawing.
- C. It shall be the responsibility of this contractor to verify and adjust shelving sizes to insure proper fit.

4.32 ITEM 132 - COOLER DUNNAGE - TWO (2) REQUIRED

- A. Cooler dunnage shall be as manufactured by Eagle, Model #QP-DRE-GL.
- B. Cooler dunnage shall be provided with EagleGard finish with louvered shelves. Cooler dunnage shall be provided with all standard equipment in sizes as shown on drawing.
- C. It shall be the responsibility of this contractor to verify and adjust dunnage rack sizes to insure proper fit.

4.33 ITEM 133 - COOLER SHELVING - ONE (1) LOT

- A. Cooler shelving shall be as manufactured by Eagle, Model #QPF-QAE-GL.
- B. Cooler shelving shall be provided with EagleGard finish, four (4) shelves high with 74" posts. Cooler shelving shall be provided with louvered shelves in sizes as shown on drawing.
- C. It shall be the responsibility of this contractor to verify and adjust shelving sizes to insure proper fit.

4.34 ITEM 134 - MILK CRATE DOLLY - ONE (1) REQUIRED

- A. Milk crate dolly shall be as manufactured by SPG/Kel-Max, Model #4J0282.
- B. Milk crate dolly shall be provided with all standard equipment, plus pull handle.

4.35 ITEM 135 - SPARE NUMBER

4.36 ITEM 136 - SPARE NUMBER

4.37 ITEM 137 - REACH-IN REFRIGERATOR - ONE (1) REQUIRED

- A. Reach-in refrigerator shall be as manufactured by Continental Refrigerator, Model #D2RNSSHD.
- B. Reach-in refrigerator shall be provided with all standard equipment, plus the following:
 - 1. One (1) Extra Shelf Per Section
 - 2. Casters with Brakes

4.38 ITEM 138 - WORKTOP REFRIGERATOR - ONE (1) REQUIRED

- A. Worktop refrigerator shall be as manufactured by Continental Refrigerator, Model #DRA60NSSBS.

- B. Worktop refrigerator shall be provided with all standard equipment, plus the following:
 - 1. Door Locks
 - 2. Casters with Brakes
 - 3. Front Breathing
- 4.39 ITEM 139 - SLICER - ONE (1) REQUIRED
 - A. Slicer shall be as manufactured by Hobart, Model #HS9-1.
 - B. Slicer shall be provided with all standard equipment, plus the following:
 - 1. Slicer Removal Tool
 - 2. Product Deflector
 - 3. Product Fence
- 4.40 ITEM 140 - SLICER STAND - ONE (1) REQUIRED
 - A. Slicer stand shall be as manufactured by F.W.E., Model #OTR-15-MSWT.
 - B. Slicer stand shall be provided with all standard equipment, plus the following:
 - 1. Perimeter Bumper
 - 2. Floor Lock
- 4.41 ITEM 141 - WORKTABLE - ONE (1) REQUIRED
 - A. Worktable shall be custom built, approximately 7'-0" x 30" x 34" high to working surface.
 - B. Worktable shall be provided with the following:
 - 1. 8" Backsplash Rear and Right End
 - 2. Undershelf
 - 3. Two (2) Drawers with Locks
 - 4. Cutting Boards Under Drawers
- 4.42 ITEM 142 - CAN OPENERS - TWO (2) REQUIRED
 - A. Can openers shall be as manufactured by Edlund, Model #270.
 - B. Can openers shall be provided with all standard equipment.
- 4.43 ITEM 143 - FOOD PROCESSOR - ONE (1) REQUIRED
 - A. Food processor shall be as manufactured by Robot Coupe, Model #R2UDICE.
 - B. Food processor shall be provided with all standard equipment, plus the following:
 - 1. Dicing Kit
 - 2. Dice Cleaning Kit
 - 3. Five Disc Set
- 4.44 ITEM 144 - SPARE NUMBER

4.45 ITEM 145 - CLEAN DISHTABLE - ONE (1) REQUIRED

- A. Clean dishtable shall be as manufactured by AeroWorks, Model #CRT0-LR-4.
- B. Clean dishtable shall be provided with all standard equipment, plus the following:

4.46 ITEM 146 - AIR DRYER - ONE (1) REQUIRED

- A. Air dryer shall be as manufactured by San-Aire, Model #PD-100-M.
- B. Air dryer shall be provided with all standard equipment, plus the following:
 - 1. Wall-Mount Bracket
 - 2. One (1) Set FILTERX4 Filter Set

4.47 ITEM 147 - DISHWASHER - ONE (1) REQUIRED

- A. Dishwasher shall be as manufactured by Hobart, Model #CL44-ADV.
- B. Dishwasher shall be provided with all standard equipment, plus the following:
 - 1. Electric Tank Heat
 - 2. Higher Than Standard Chamber
 - 3. Splash Curtains Each End
 - 4. Built-In Booster
 - 5. Drain Water Tempering Kit
 - 6. Shock Absorbers (2)
 - 7. Water Softening System
 - 8. Table Limit Switch
 - 9. Flange Feet Kits
 - 10. Vent Cowls Each End
 - 11. Three (3) Peg Racks
 - 12. Three (3) Combination Racks
 - 13. Two (2) Sheet Pan Racks

4.48 ITEM 148 - DUCT RISERS - TWO (2) REQUIRED

- A. Duct risers shall be custom built, 4" x 16".
- B. Duct risers shall be custom fabricated of 18 gauge stainless steel. All seams shall be continuously welded, ground and polished to eliminate any leakage of condensation. Ducts shall run from each vent cowl on the dishmachine to a point 3" above finished ceiling.

4.49 ITEM 149 - SOILED DISHTABLE - ONE (1) REQUIRED

- A. Soiled dishtable shall be custom built, size and shape as shown on drawing x 34" high to working surface.
- B. Soiled dishtable shall be provided with the following:
 - 1. 10" Backsplash
 - 2. Pre-Rinse Sink with Rack Guide
 - 3. Install Disposer (Item #11)
 - 4. Crossbracing

5. T&S #B-0133-B-KIT Pre-Rinse with Bracket

4.50 ITEM 150 – SPARE NUMBER

4.51 ITEM 151 - POT/PAN SINK - ONE (1) REQUIRED

- A. Pot/pan sink shall be custom built, approximately 9'-4" x 33" x 34" high to working surface.
- B. Pot/pan sink shall be provided with the following:
 - 1. 10" Backsplash Along Wall Areas
 - 2. Three (3) 20" x 28" Sink Compartments
 - 3. Crossbracing
 - 4. Flange Feet
 - 5. One (1) T&S #B-0133-A128-KIT Pre-Rinse with Bracket and Add-On Faucet
 - 6. One (1) T&S #B-2463/B-0230-KIT Faucet with Aerator
 - 7. Three (3) T&S #B-3972-01 Leverwastes with Overflow

4.52 ITEM 152 - HOSE REEL - ONE (1) REQUIRED

- A. Hose reel shall be as manufactured by T&S, Model #B-2339.
- B. Hose reel shall be provided with all standard equipment.

4.53 ITEM 153 - EMERGENCY EYE WASH STATION - ONE (1) REQUIRED

- A. Emergency eye wash station shall be as manufactured by T&S, Model #EW-7360B-TMV.
- B. Emergency eye wash station shall be provided with all standard equipment.

4.54 ITEM 154 - HAND SINKS - TWO (2) REQUIRED

- A. Hand sinks shall be as manufactured by Eagle, Model #HSA-10-MG.
- B. Hand sinks shall be provided with all standard equipment, plus the following:
 - 1. Micro-Gard
 - 2. Single Faucet Hole
 - 3. Gooseneck Faucet
 - 4. Tail Piece
 - 5. P-Trap
 - 6. T&S #B-504 Wall-Mounted Foot Pedal

4.55 ITEM 155 - POT/PAN RACK - ONE (1) REQUIRED

- A. Pot/pan rack shall be as manufactured by Metro, Model #PR48VX3-XDR.
- B. Pot/pan rack shall be provided with all standard equipment.

4.56 ITEM 156 - WORKTABLE - ONE (1) REQUIRED

- A. Worktable shall be custom built, approximately 4'-0" x 30" x 34" high to working surface.
- B. Worktable shall be provided with the following:

1. Undershelf
2. One (1) Drawer with Lock
3. Casters, All with Brakes

4.57 ITEM 157 - WORKTABLE - ONE (1) REQUIRED

- A. Worktable shall be custom built, approximately 5'-6" x 30" x 34" high to working surface.
- B. Worktable shall be provided with all standard equipment, plus the following:
 1. Undershelf
 2. Two (2) Drawers with Locks
 3. Casters, All with Brakes

4.58 ITEM 158 - SPARE NUMBER

4.59 ITEM 159 - HEATED CABINETS - TWO (2) REQUIRED

- A. Heated cabinets shall be as manufactured by F.W.E., Model #MTU-5-5.
- B. Heated cabinets shall be provided with all standard equipment, plus the following:
 1. Perimeter Bumper
 2. Casters with Brakes

4.60 ITEM 160 - ROLL-IN REFRIGERATORS - TWO (2) REQUIRED

- A. Roll-in refrigerators shall be as manufactured by Continental Refrigerator, Model #D2RINSS.
- B. Roll-in refrigerators shall be provided with all standard equipment.

4.61 ITEM 161 - BACK COUNTER - ONE (1) REQUIRED

- A. Back counter shall be custom built, approximately 3'-0" x 30" x 34" high to working surface.
- B. Back counter shall be provided with the following:
 1. 6" Backsplash
 2. Enclosed Base with Hinged Doors
 3. Casters, All with Brakes

4.62 ITEM 162 - VENTELESS PIZZA OVEN - ONE (1) REQUIRED

- A. Venteless pizza oven shall be as manufactured by Turbo Chef, Model #HCT-4215-Double.
- B. Venteless pizza oven shall be provided with all standard equipment, plus the following:
 1. Stacking Kit
 2. #HCT-3004-2 Stand with Casters
 3. TurboChef Guard Kit
 4. TurboChef Powder Cleaner Kit
 5. Dual Catalytic Converters
 6. T&S Posi-Set

4.63 ITEM 163 - PIZZA PREP REFRIGERATOR - ONE (1) REQUIRED

- A. Pizza prep refrigerator shall be as manufactured by Continental Refrigerator, Model #PA43N.
- B. Pizza prep refrigerator shall be provided with all standard equipment, plus the following:
 - 1. Stainless Steel Interior
 - 2. Overshelf
 - 3. Door Locks
 - 4. Casters with Brakes

4.64 ITEM 164 - FLAT TOP COUNTERS - TWO (2) REQUIRED

- A. Flat top counters shall be as manufactured by Piper, Model #2-ST.
- B. Flat top counters shall be provided with all standard equipment, plus the following:
 - 1. #SRTS Tray Slide
 - 2. #SCB Fold Down Work Shelf
 - 3. Open Understorage with Shelf
 - 4. Laminate
- C. Color to be as selected by Architect.

4.65 ITEM 165 - SANDWICH COUNTER - ONE (1) REQUIRED

- A. Sandwich counter shall be as manufactured by Piper, Model #3-CM.
- B. Sandwich counter shall be provided with all standard equipment, plus the following:
 - 1. #SRTS Tray Slide
 - 2. #SCB Fold Down Work Shelf
 - 3. Open Understorage with Shelf
 - 4. Protector Guard
 - 5. LED Lighting
 - 6. PANS & DIVIDERS
 - 7. Laminate
- C. Color to be as selected by Architect.

4.66 ITEM 166 - PIZZA COUNTER - ONE (1) REQUIRED

- A. Pizza counter shall be as manufactured by Piper, Model #5-HT-MOD.
- B. Pizza counter shall be provided with all standard equipment, plus the following:
 - 1. #SRTS Tray Slide
 - 2. Top Modified to 34" Deep
 - 3. #SCB Fold Down Work Shelf
 - 4. #SCB Fold Down Work Shelf
 - 5. Open Understorage with Shelf
 - 6. Serve/Self Serve Counter Protector
 - 7. LED Lighting
 - 8. Laminate

C. Color to be as selected by Architect.

4.67 ITEM 167 - GRAB-N-GO REFRIGERATORS - TWO (2) REQUIRED

A. Grab-n-go refrigerators shall be as manufactured by Beverage Air, Model #VMHC-18-1-B.

B. Grab-n-go refrigerators shall be provided with all standard equipment, plus the following:

1. 5" Casters with Brakes
2. Security Cage with Lock

4.68 ITEM 168 - SALAD COUNTER - ONE (1) REQUIRED

A. Salad counter shall be as manufactured by Piper, Model #5-CM-MOD.

B. Salad counter shall be provided with all standard equipment, plus the following:

1. #SRTS Tray Slide
2. Top Modified to 34" Deep
3. #SCB Fold Down Work Shelf
4. Open Understorage with Shelf
5. Serve/Self Serve Counter Protector
6. LED Lighting
7. Laminate

C. Color to be as selected by Architect.

4.69 ITEM 169 - HOT FOOD COUNTER - ONE (1) REQUIRED

A. Hot food counter shall be as manufactured by Piper, Model #5-HF-MOD.

B. Hot food counter shall be provided with all standard equipment, plus the following:

1. #SRTS Tray Slide
2. Top Modified to 34" Deep
3. Open Understorage with Shelf
4. Individual Drains Plumbed to Common Valve
5. Serve/Self Serve Counter Protector
6. LED Lighting
7. Laminate

C. Color to be as selected by Architect.

4.70 ITEM 170 - SPARE NUMBER

4.71 ITEM 171 - MILK CABINETS - TWO (2) REQUIRED

A. Milk cabinets shall be as manufactured by Continental Refrigerator, Model #MC4NSSS.

B. Milk cabinets shall be provided with all standard equipment, plus the following:

1. Wrap Around Bumper
2. Floor Lock

4.72 ITEM 172 - SILVERWARE CARTS - TWO (2) REQUIRED

- A. Silverware carts shall be as manufactured by Piper, Model #715-1-A10.
- B. Silverware carts shall be provided with all standard equipment, plus the following:
 - 1. Rotating Bumpers
 - 2. Twenty (20) Nylon Cylinders Per Cart
 - 3. Casters with Brakes

4.73 ITEM 63 - TRAY DISPENSERS - TWO (2) REQUIRED

- A. Tray dispensers shall be as manufactured by Piper, Model #ATCA-ST.
- B. Tray dispensers shall be provided with all standard equipment, plus the following:
 - 1. Perimeter Bumper
 - 2. Casters with Brakes
- C. It shall be the responsibility of this contractor to verify tray size with Owner.

4.74 ITEM 174 - FLAT TOP COUNTER - ONE (1) REQUIRED

- A. Flat top counter shall be as manufactured by Piper, Model #2-ST.
- B. Flat top counter shall be provided with all standard equipment, plus the following:
 - 1. #SRTS Tray Slide, Each Side
 - 2. Laminate
- C. Color to be as selected by Architect.

4.75 ITEM 175 - HOT/COLD FOOD COUNTER - ONE (1) REQUIRED

- A. Hot/cold food counter shall be as manufactured by Piper, Model #4-ST.
- B. Hot/cold food counter shall be provided with all standard equipment, plus the following:
 - 1. #SRTS Tray Slide, Each Side
 - 2. Cut Out for Hot/Cold/Freeze Unit (Item #180)
 - 3. Double Sided Display Case
 - 4. LED Lighting
 - 5. Laminate
- C. Color to be as selected by Architect.

4.76 ITEM 176 - ICE CREAM CABINET - THREE (3) REQUIRED

- A. Ice cream cabinet shall be as manufactured by Beverage Air, Model #NC28-1-W.
- B. Ice cream cabinet shall be provided with all standard equipment.

4.77 ITEM 177 - CASHIER COUNTERS - TWO (2) REQUIRED

- A. Cashier counters shall be as manufactured by Piper, Model #2-CS-MOD.

B. Cashier counters shall be provided with all standard equipment, plus the following:

1. #SRTS Tray Slide
2. Tubular Foot Rest
3. Modified to 42" Long
4. Laminate

C. Color to be as selected by Architect.

4.78 ITEM 178 - CASH REGISTERS - THREE (3) - NIC/BY OWNER

4.79 ITEM 179 - CASHIER COUNTER - ONE (1) REQUIRED

A. Cashier counter shall be as manufactured by Piper, Model #2-CS-MOD.

B. Cashier counter shall be provided with all standard equipment, plus the following:

1. #SRTS Tray Slide, Each Side
2. Tubular Foot Rest
3. Modified to 42" Long
4. Laminate

C. Color to be as selected by Architect.

4.80 ITEM 180 - HOT/COLD/FREEZE UNIT - ONE (1) REQUIRED

A. Hot/cold/freezer unit shall be as manufactured by Duke, Model #HCF-3.

B. Hot/cold/freezer unit shall be provided with all standard equipment.

PART 5 - DETAILS OF CONSTRUCTION

5.1 DETAIL DRAWINGS

A. The following details are a part of these specifications and shall be referred to for design requirements:

END OF SECTION 114000

SECTION 11 53 63 - LABORATORY EQUIPMENT AND ACCESSORIES**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Safety Goggle Cabinet
 - 2. Fire Blanket
 - 3. First Aid Kit

1.3 SUBMITTALS, GENERAL

- A. General: Submit all action submittals required by this Section concurrently.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples for Initial Selection: For factory-applied finishes and other materials requiring color selection.

1.5 QUALITY ASSURANCE

- A. Flammable Liquid Storage: Where cabinets are indicated for solvent or flammable liquid storage, provide units that are listed and labeled as complying with requirements in NFPA 30 by a testing and inspecting agency acceptable to authorities having jurisdiction.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect finished surfaces during handling and installation with protective covering of polyethylene film or other suitable material.

1.7 COORDINATION

- A. Coordinate installation of laboratory equipment and accessories with installation of other laboratory equipment.

PART 2 - PRODUCTS

2.1 LABORATORY EQUIPMENT

- A. Germicidal Goggle Sterilization Cabinet: Painted 24-gauge steel cabinet with lockable doors, 28" x 26" x 10", for wall mounting, and capacity to sanitize a minimum of 30 pairs of safety glasses. Equip with automatic timer and germicidal bulbs. 0.21 amps, 120V (25 w) with a 3-wire grounded 8' cord. UL listed.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Flinn Scientific., "SE1001, 28"H x 26" W x 10"D Germicidal Goggles Sterilization Cabinet" or comparable product.
- B. Fire Blankets: Painted steel cabinet with drop hinge door, for wall mounting, containing 100 percent wool, and naturally fire retardant, Metal Cabinet is 16"H x 18"W x 5 1/4"D , fire blanket 62 inches by 80 inches in size.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Flinn Scientific. "SE3006 Series" Metal Case or comparable product.
- C. First Aid Kits: Steel cabinet, for wall mounting, containing first aid supplies and instructions. Included in kit: adhesive bandages, adhesive bandages with non-adherent pads, bandage compress, gauze pads, triangle bandages, burn cream, two sizes of stretch bandages, adhesive tape, non-adherent pads, eye flush with eye pads, eye cup and tape, antiseptic towelettes, cold pack, latex gloves, forceps, and scissors.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Flinn Scientific., "SE1083 50 person, 9 1/2"H x 9"W x 2 1/2"D First Aid Kit" or comparable product.

2.2 ELECTRICAL SERVICE FITTINGS

- A. Service Fittings, General: Provide units complete with metal housings, receptacles, terminals, switches, pilot lights, device plates, accessories, and gaskets required for mounting.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances, location of reinforcements, and other conditions affecting performance of laboratory equipment and accessories.

- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 INSTALLATION OF LABORATORY EQUIPMENT AND ACCESSORIES

- A. Install accessories according to Shop Drawings, installation requirements in SEFA 2.3, and manufacturer's written instructions.
- B. Securely fasten units to partition framing or reinforcements in partitions.

3.3 INSTALLATION OF SERVICE FITTINGS

- A. Comply with requirements in other Sections for installing electrical devices.
- B. Install fittings according to manufacturer's written instructions.

3.4 CLEANING AND PROTECTING

- A. Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.

END OF SECTION 11 53 63

SECTION 12 24 13 - ROLLER WINDOW SHADES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Manually operated roller shades with single rollers.
 - 2. Roller shade fabrics.

1.3 SUBMITTALS, GENERAL

- A. General: Submit all action submittals (except Samples for Verification) and informational submittals required by this Section concurrently.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include styles, material descriptions, construction details, dimensions of individual components and profiles, features, finishes, and operating instructions for roller shades.
- B. Shop Drawings: Show fabrication and installation details for roller shades, including shadeband materials, their orientation to rollers, and their seam and batten locations, all dimensions and clearances for each shade installation.
 - 1. Include typical elevation layout showing separation between shade units and meeting edges at corners with sections and details at head and sill between blind units and corners.
 - 2. Provide verified in field details showing all types of shade installation conditions.
 - 3. Components and conditions not fully dimensioned or detailed in manufacturers product data indicating relationship to adjoining construction.
 - 4. Manufacturers specification instructions and details specific to components and conditions not fully dimensioned or detailed in manufacturers product data.
 - 5. Provide data for all components required for installation.
- C. Samples for Verification and Initial Color Selection: For each type and color of shadeband material.
 - 1. Include Samples of accessories involving color selection.
 - 2. Actual color samples of manufacturers full range – no color copies will be accepted.

3. Shadeband Material: Not less than 10 inches square. Mark inside face of material if applicable.
4. Roller Shade: Full-size operating unit, not less than 16 inches wide by 36 inches long for each type of roller shade indicated.
5. Installation Accessories: Full-size unit, not less than 10 inches long.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of shadeband material, signed by product manufacturer.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For roller shades to include in maintenance manuals.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roller shades in factory packages, marked with manufacturer, product name, and location of installation using same designations indicated on Drawings.

1.8 WARRANTY

- A. Manufacturer's Warranty - Provide manufacturer's warranty including coverage of at least following components:
 1. Corrosion of all metal parts.
 2. Sagging, creasing, or breaking of slats.
 3. Sagging, creasing or ripping of shadeband material.
 4. Smoothly performing mechanism without slippage or jams.
 5. Finish of all components matching in color, uniform, and against fading or discoloration.
 6. Defects in materials and installation workmanship.

1.9 FIELD CONDITIONS

- A. Environmental Limitations: Do not install roller shades until construction and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- B. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain roller shades from single source from single manufacturer.

2.2 MANUALLY OPERATED SHADES WITH SINGLE ROLLERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Draper Inc.; Manual FlexShade Systems or comparable product by one of the following:
 - 1. Hunter Douglas Contract.
 - 2. MechoShade Systems, Inc.
- B. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated; with chain retainer.
 - 1. Bead Chains: Manufacturer's standard.
 - a. Limit Stops: Provide upper and lower ball stops.
- C. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.
 - 1. Direction of Shadeband Roll: Regular, from back of roller.
 - 2. Shadeband-to-Roller Attachment: Manufacturer's standard method- no double-side tape will be accepted. Provide adequate brackets on multiple sash windows to hold roller pin ends no more than 1/8 inch apart over centerline of mullion.
- D. Shadebands:
 - 1. Shadeband Material: Light-blocking fabric similar to "Sun-Bloc Series" fabric by Draper Inc.
- E. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
 - 1. Type: Enclosed in sealed pocket of shadeband material.
- F. Fabrication:
 - 1. Cut shades perfectly square and true and mount on rollers using suitable fasteners. Provide all material used in shade manufacture new, commercially perfect and of first quality. Provide material in one piece.

2. Provide one finished length of each single hung shade after hemming 14 inches longer than portion of sash covered by shade. Provide finished shade width to cover adequately, but not more than 1/4 inch of barrel exposed at each end of roller.
 - a. Where necessary, increase diameter of roller from 1-1/4 inches to correspond with size of shade.
 - b. Provide hems of proper width for slat, double turn hems, and sew with straight stitch. Neatly backstitch all hems at the ends.
 - c. Hem at top and bottom of shade.
3. Fabrication Tolerances:
 - a. Size shades to fit openings head to sill (allowing for 6 to 10 inches in additional length) and between mullions, unless otherwise indicated on Drawings.
 - b. Provide single sets of shades no greater in width than distance between 2 mullions at openings up to 15 ft. wide.
 - c. Provide minimum clearances for appropriate operation of shades.

G. Installation Accessories:

1. Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.
 - a. Shape: L-shaped.
 - b. Height: Manufacturer's standard height required to conceal roller and shadeband when shade is fully open.
 - c. Provide full range of manufactures colors.
2. Exposed Headbox: Rectangular, extruded-aluminum enclosure including front fascia, top and back covers, endcaps, and removable bottom closure.
 - a. Height: Manufacturer's standard height required to enclose roller and shadeband when shade is fully open.
 - b. Provide full range of manufactures colors.
3. Endcap Covers: To cover exposed endcaps.
4. Installation Accessories Color and Finish: As selected from manufacturer's full range.

2.3 MOTOR-OPERATED, SINGLE-ROLLER SHADES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Draper Inc; Motorized FlexShade Systems or comparable product by one of the following:
1. Hunter Douglas Contract.
 2. MechoShade Systems, Inc.

- B. Motorized Operating System: Provide factory-assembled, shade-operator system of size and capacity and with features, characteristics, and accessories suitable for conditions indicated, complete with electric motor and factory-prewired motor controls, power disconnect switch, enclosures protecting controls and operating parts, and accessories required for reliable operation without malfunction. Include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with building electrical system.
1. Electrical Components: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Electric Motor: Manufacturer's standard tubular, enclosed in roller.
 - a. Electrical Characteristics: Single phase, 24, 110, 220 V, 60 Hz.
 3. Remote Control: Electric controls with NEMA ICS 6, Type 1 enclosure for recessed or flush mounting. Provide the following for remote-control activation of shades:
 - a. Group Control Station: Maintained, Momentary-contact, three-position, rocker-style, wall-switch-operated control station with open, close, and center off functions for single-switch group control.
 - b. Color: As selected by Architect from manufacturer's full range.
 4. Limit Switches: Adjustable switches interlocked with motor controls and set to stop shades automatically at fully raised and fully lowered positions.
 5. Operating Features:
 - a. Group switching with integrated switch control; single faceplate for multiple switch cutouts.
 - b. Override switch.
- C. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.
1. Direction of Shadeband Roll: Regular, from back of roller.
 2. Shadeband-to-Roller Attachment: Manufacturer's standard method- no double-side tape will be accepted. Provide adequate brackets on multiple sash windows to hold roller pin ends no more than 1/8 inch apart over centerline of mullion.
- D. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.
- E. Shadebands:
1. Shadeband Material: Light-blocking fabric similar to "Sun-Bloc Series" fabric by Draper Inc.

2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
 - a. Type: Enclosed in sealed pocket of shadeband material.

F. Installation Accessories:

1. Front Fascia: Aluminum extrusion, baked finish, that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.
 - a. Shape: L-shaped.
 - b. Height: Manufacturer's standard height required to conceal roller and shadeband when shade is fully open.
2. Endcap Covers: To cover exposed endcaps.
3. Side Channels: With light seals and designed to eliminate light gaps at sides of shades as shades are drawn down.
4. Bottom (Sill) Channel or Angle: With light seals and designed to eliminate light gaps at bottoms of shades when shades are closed.
5. Installation Accessories Color and Finish: As selected from manufacturer's full range.

2.4 SHADEBAND MATERIALS

- A. Shadeband Material Flame-Resistance Rating: Comply with NFPA 701. Testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- B. Light-Blocking Fabric: Opaque fabric, stain and fade resistant.
 1. Source: Roller-shade manufacturer.
 2. Type: Fiberglass textile with PVC film bonded to both sides.
 3. Thickness: 0.015 inches.
 4. Weight: 12 oz./sq. yd.
 5. Features: Washable.
 6. Color: As selected by Architect from manufacturer's full range.
 7. Basis-of-Design Product: Subject to compliance with requirements, provide Draper Inc.; SunBloc Series SB9000 or comparable product.
- C. Rescue Window Labels: Provide and install on window shade in every space of pupil occupancy opaque labels with words "RESCUE WINDOW" Install labels on shades associated with rescue window coordinate with Architect for location.
 1. Color: Opaque, bright yellow background with black letters.
 2. Size: 2 inches by 1 inches, 3/8" wide lines to form letters.
 3. Text: "RESCUE WINDOW", readable from room side of window.

2.5 ROLLER-SHADE FABRICATION

- A. Product Safety Standard: Fabricate roller shades to comply with WCMA A 100.1, including requirements for flexible, chain-loop devices; lead content of components; and warning labels.
- B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F:
 - 1. Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which shade is installed less 1/4 inch per side or 1/2-inch total, plus or minus 1/8 inch. Length equal to head-to-sill dimension of opening in which shade is installed less 1/4 inch, plus or minus 1/8 inch.
 - 2. Outside of Jamb Installation: Width and length as indicated, with terminations between shades of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.
- C. Shadeband Fabrication: Fabricate shadebands without battens or seams to extent possible.
- D. Rescue Window Labels: Provide and install on window shade in every space of pupil occupancy opaque labels with words "RESCUE WINDOW" Install labels on shades associated with rescue window coordinate with Architect for location.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 ROLLER-SHADE INSTALLATION

- A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions.
 - 1. Opaque Shadebands: Located so shadeband is not closer than 2 inches to interior face of glass. Allow clearances for window operation hardware.
 - 2. Hang shades at window to fit opening properly and operate smoothly and efficiently. Hang each shade perfectly level and with spring tension of roller properly adjusted. Locate tips of adjoining shades no further than 3/8 inch apart when two or more are mounted back to back.

3. Install each shade on brackets securely fastened to ceiling or wall as shown on Drawings. Furnish and install new brackets and other hardware required for proper installation of shades.
- B. Prior to installation of roller-shade units, coordinate installation locations and method of installation with window manufacturer, do not secure roller-shade units to window frame.

3.3 ADJUSTING

- A. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

3.4 CLEANING AND PROTECTION

- A. Clean roller-shade surfaces after installation, according to manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that roller shades are without damage or deterioration at time of Substantial Completion.
- C. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain motor-operated roller shades.

END OF SECTION 12 24 13

SECTION 12 32 13 - MANUFACTURED WOOD-VENEER-FACED CASEWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes manufactured wood-veneer-faced cabinets of stock design.
- B. Section Includes
 - 1. Wood-veneer faced casework - overlay door design, including (but not limited to):
 - a. Wall, base, and tall cabinets
 - b. Tops for all base units
 - c. Countertop assemblies
 - d. Solid Surface windowsills
 - e. Spray Both units
 - f. Safety station units
 - g. Fume Hood
 - h. Laboratory Accessories
 - 2. Accessory items, including:
 - a. All filler panels, frame units, scribe strips, strips at walls, and similar items.
 - b. Cutouts for sinks, faucets, fittings, and other plumbing and electrical fixtures, electrical and mechanical runs and connections and similar items.
 - c. Epoxy resin countertops and sinks, drains and tail pieces.
 - d. Materials and devices necessary to make solid connections to existing structure
- C. Products Furnished but not Installed Under this Section
 - 1. Mechanical components, electrical components, plumbing components, and similar items included with specified casework items; refer to "Sequencing and Scheduling".

1.3 DEFINITIONS

- A. Definitions in the AWI's, AWMAC's, and WI's "Architectural Woodwork Standards" apply to the work of this Section.
- B. MDF: Medium-density fiberboard.

- C. Hardwood Plywood: A panel product composed of layers or plies of veneer, or of veneers in combination with lumber core, hardboard core, MDF core, or particleboard core, joined with adhesive and faced both front and back with hardwood veneers.

1.4 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that casework can be supported and installed as indicated.

1.5 SUBMITTALS, GENERAL

- A. General: Submit all action submittals (except Samples for Verification) required by this Section concurrently.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1. Casework.
2. Hinges.
3. Pulls.
4. Door catches.
5. Label holders.
6. Drawer and hinged door locks.
7. Adjustable shelf supports.
8. Wardrobe rod.
9. Coat hooks.
10. Closet rod and shelf.
11. Grilles.
12. Fume Hood units
13. Spray Booth units
14. Emergency Eyewash units
15. Laboratory Accessories

- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work. Show fabrication details, including types and locations of hardware. Show installation details, including field joints and filler panels. Indicate manufacturer's catalog numbers for casework.

1. Roughing Drawings: Submit roughing drawings, showing complete roughing dimensions for plumbing, ventilating and electric services and components to be installed in casework, including location of existing roughing and dimensions, where applicable.
2. Groups/Assemblies: Submit shop drawings of groups or assemblies, including descriptions identifying units, parts, and accessories of each item and showing materials, dimensions, cabinet-cut details, and sink locations (where applicable).

3. Field Measurements: Prior to fabrication or ordering of any specified casework items, verify measurement at Site of actual space reserved for casework items; DO NOT take measurements from Contract Drawings. Give due consideration to architectural, structural, or mechanical discrepancies occurring during building construction. Make such discrepancies immediately known to Architect and obtain clarification of discrepancy in writing before proceeding with installation of affected casework items.
4. Color/Finishes: Shop drawings are not to include colors, wood finishes, stains, etc. All colors are to be selected by the Architect and issued to the contractor by an ASI during the construction phase.

C. Samples:

1. Casework Units: Without cost to Owner, submit samples, as requested, to demonstrate Contractor's ability to furnish required casework.
2. Color Selection: Submit actual samples of finishes, colors, and materials as required for color selection. Submit full range of manufacture colors, texture, and wood tones.

D. Mock-Ups: Submit following units for comparison with items installed as part of casework installation. Mock-up units must be submitted prior to or with casework submittal. Casework submittals and shop drawings will not be approved without mock-up units.

1. One full-size [mini cabinet] base cabinet unit complete with hardware, doors, and drawers, without finish top.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.

1. Joint Tolerances 400C-T-1.
2. Finishes Test 400C-T-2.

C. Sample Warranty: For requirements of warranty refer to section 1.14 of this specification.

D. Installer Experience Listing: Submit list of completed projects using products proposed for this Project, including owner's contact and telephone number for each project, demonstrating compliance with applicable "Qualifications" requirements specified below in "Quality Assurance" article.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish complete touchup kit for each type and finish of casework provided. Include scratch fillers, stains, finishes, and other materials necessary to perform permanent repairs to damaged casework finish.

1.9 QUALITY ASSURANCE

- A. Manufacturer: Minimum 5-years' experience in manufacture of casework and other items similar to those specified and minimum 5 completed casework installations of similar size and requirements to that specified.
- B. Installer: Minimum 5 completed casework installations of similar size and requirements to that specified.
- C. Installer Qualifications: An authorized representative who is trained and/or approved by manufacturer for installation of units required for this Project.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver casework only after painting, utility roughing-in, and similar operations that could damage, soil, or deteriorate casework have been completed in installation areas. If casework must be stored in other than installation areas, store only in areas where environmental conditions meet requirements specified in "Project Conditions" Article.
- B. Keep finished surfaces covered with polyethylene film or other protective covering during handling and installation.

1.11 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install casework until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period. Maintain temperature and relative humidity during the remainder of the construction period in range recommended for Project location by the AWI's, "Architectural Woodwork Standards."
- B. Field Measurements: Prior to fabrication or ordering of any specified casework items, verify measurement at Site of actual space reserved for casework items; DO NOT take measurements from Contract Drawings. Give due consideration to architectural, structural, or mechanical discrepancies occurring during building construction. Make such discrepancies immediately known to Architect and obtain clarification of discrepancy in writing before proceeding with installation of affected casework items. Locate concealed framing, blocking, and reinforcements that support casework by field measurements before being enclosed and indicate measurements on Shop Drawings.

1.12 SEQUENCING AND SCHEDULING

- A. Coordinate the layout and installation of casework with all Prime Contractors. See Section 01 12 00 for each Contractor's coordination responsibilities.
- B. Refer to the casework model numbers for the plumbing and electrical fittings and fixtures that are shown to be part of the casework. Deliver these fittings and fixtures to the contractor assigned to their installation in Section 01 12 00. Obtain a signed receipt for their delivery.

- C. Provide all holes / cut outs in the casework for all Prime Contractors on the Project. Coordinate with the work on the E, P, & HVAC Drawings, and Division 22, 23, 26, 27, and 28.

1.13 MAINTENANCE

- A. Extra Materials: Furnish complete touchup kit for each type and color of wood laboratory casework provided. Include scratch fillers, stains, finishes, and other materials necessary to perform permanent repairs to damaged laboratory casework finish.

1.14 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of casework that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Delamination of components or other failures of glue bond.
 - b. Warping of components.
 - c. Failure of operating hardware.
 - d. Deterioration of finishes.
 - 2. Contractor's Guarantee: Upon completion of installation of casework and after acceptance by Owner, furnish to Owner written statement accepting full responsibility for installation and guaranteeing adequacy and safety of attachment of all casework.
 - 3. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide "Traditional Series 1" casework" by CIF Lab Solutions or comparable product by one of the following:
 - 1. Diversified Casework
 - 2. Kewaunee Scientific Corporation.
 - 3. Leonard Peterson Co., Inc.
- C. Source Limitations: Obtain wood-veneer-faced casework with tops, sinks, special equipment, and service fixtures from same casework supplier to establish single responsibility for all casework components.

2.2 CASEWORK, GENERAL

- A. Quality Standard: Unless otherwise indicated, comply with the AWI's, AWMAC's, and WI's "Architectural Woodwork Standards" for grades of casework indicated for construction, finishes, installation, and other requirements.
 - 1. Grade: Premium
 - 2. Provide labels and certificates from AWI certification program indicating that casework, including installation, complies with requirements of grades specified.
- B. Product Designations: Drawings indicate sizes, configurations, and finish materials of manufactured wood-veneer-faced casework by referencing designated manufacturer's catalog numbers. Other manufacturers' casework of similar sizes and door and drawer configurations, of same finish materials, and complying with the Specifications may be considered. See Section 01 60 00 "Product Requirements."
- C. Product Designations: Drawings indicate configurations of manufactured wood-veneer-faced casework by referencing designations of Casework Design Series numbering system in Appendix A of the AWI's, AWMAC's, and WI's "Architectural Woodwork Standards."

2.3 FULL FRAME WOOD-VENEER-FACED CABINETS

- A. Design:
 - 1. Lipped overlay with radiused wood edges.
- B. Wood Species: Red oak.
- C. Face Veneer Cut: Grade AA Plain sliced.
- D. Veneer Matching:
 - 1. Provide veneers for each cabinet from a single flitch, book and running, book and balance matched.
 - a. Provide continuous matching of adjacent drawer fronts within each cabinet.
- E. Grain Direction:
 - 1. Vertical on doors, horizontal on drawer fronts.
 - 2. Lengthwise on face frame members.
 - 3. Vertical on end panels.
 - 4. Side to side on bottoms and tops of units.
 - 5. Vertical on knee-space panels.
 - 6. Horizontal on aprons.

F. Exposed Materials:

1. Plywood:

- a. Red Oak,: Grade AA-1, plain sliced, book matched, cross-banded, with solid hardwood core.
 - 1) 1/4 inch: Minimum 3-ply MDF core or 5 ply hardwood veneer cores.
 - 2) 1/2 inch: Minimum 5 ply hardwood veneer core
 - 3) 3/4 inch: Minimum 7-ply hardwood veneer core.
 - 4) 1 inch: Minimum 9-ply hardwood veneer core.
 - b. Other Hardwood Plywood: Sound grade; cross-banded, with solid hardwood core.
 - 1) 1/4 inch: Minimum 3-ply MDF core.
 - 2) 1/2 inch: Minimum 5 ply hardwood veneer core
 - 3) 3/4 inch: Minimum 7-ply hardwood veneer core.
 - 4) 1 inch: Minimum 9-ply hardwood veneer core.
 - c. All Doors will be Grade AA veneer of same species, vertical grain orientation and be slip matched veneer, center balance matched per cabinet. Paired doors to be matched to each other. Drawer Fronts will be solid hardwood of same species, horizontal grain.
2. Solid Wood: Red Oak clear hardwood lumber and selected for grain and color compatible with exposed plywood.
- a. Edge banding: All banded edges (cabinet frames, end panels, tops, bottoms and shelving) to be solid 3/8-inch hardwood edge to match the cabinet species.
 - b. All solid wood is to match the selected species for all exposed and semi-exposed components.

G. Semi Exposed Materials:

- 1. Solid Wood: Sound hardwood lumber, selected to eliminate appearance defects, of same species as exposed wood.
- 2. Plywood: Hardwood plywood of same species as exposed wood. Provide backs of same species as faces.
- 3. Provide solid wood or hardwood plywood for semi-exposed surfaces unless otherwise indicated.
- 4. MDF: Use only for cabinet backs where exterior side of back is not exposed.

H. Hardboard: Full tempered 2 sides, consisting of steam-exploded wood fibers, highly compressed into hard, dense 1/4-inch-thick homogeneous sheet using natural resins and other added binders; providing following physical properties:

- 1. Modulus of Rupture: 5,000 PSI
- 2. Density: 56 PCF
- 3. Internal Bond: 100.0 PSI

- I. Particleboard: Industrial grade meeting or exceeding CS 236-66 and ASTM D1037 with following physical properties:
 - 1. Density:.....47 PCF (+10 percent)
 - 2. Interior Bond:..... 60 PSI
 - 3. Modulus of Elasticity:..... 400,000 PSI
 - 4. Modulus of Rupture:.....2,400 PSI
 - 5. Screw Holding Power - Face: 225 lbs.
 - 6. Screw Holding Power - Edge:....200 lbs.

2.4 MATERIALS

- A. Maximum Moisture Content for Lumber: 6-9 percent for hardwood. No softwoods to be used
- B. Hardwood Plywood: HPVA HP-1 hardwood veneer core except where MDF is indicated
- C. Marine Grade Hardwood Plywood: typical for all countertop applications.
- D. Particleboard: ANSI A208.1, Minimum Grade M-2
- E. MDF: ANSI A208.2, Grade 130
- F. Hardboard: ANSI A135.4, Class 1 Tempered.
- G. Edge banding: Minimum 3/8-inch- thick, solid wood of same species as face veneer. 3mm is not acceptable.
 - 1. Select wood edge banding for grain and color compatible with face veneers.
 - 2. Colors: To match cabinet face, as selected by Architect from manufacturer's full range.
- H. Glass for Glazed Doors: Clear tempered glass complying with ASTM C 1048, Kind FT, Condition A, Type I, Class 1, Quality-Q3; not less than 5.0 mm thick.
- I. Solid Surface countertop material:
 - 1. Provide countertops with the following front style: 1-1/4" front profile thickness, fabricated from 1/2-inch thick, solid surface material.
 - 2. Splashes: 4" high unless noted otherwise, of 1/2-inch thick solid surface material.
 - 3. Fabrication: Fabricate tops in one piece on MDF, with shop-applied edges unless otherwise indicated. Comply with solid-surface-material manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
 - 4. Solid Surface Material: Homogeneous solid sheets of filled plastic resin complying with ANSI SS1, Class A.
 - 5. Fabricate with loose splashes for field assembly.
 - 6. Adhesives: Adhesives shall not contain urea formaldehyde.

7. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Corian
 - b. Formica Corporation.
 - c. Wilsonart International.
 - d. Hanex Solid Surfaces.
8. Colors and Patterns: As selected by Architect from manufacturer's full range.

J. Solid Surface windowsills and aprons:

1. Solid-Surfacing Material Thickness: 1/2-inch.
2. Fabrication: Fabricate stools and aprons in one piece, unless otherwise indicated. Comply with solid-surface-material manufacturer's written instructions for adhesives, sealers, fabrication, and finishing
3. Adhesives: Adhesives shall not contain urea formaldehyde.
4. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Hanex Solid Surfaces
 - b. Corian
 - c. Formica Corporation.
 - d. Wilsonart International.
5. Colors and Patterns: As selected by Architect from manufacturer's full range.

2.5 CASEWORK FABRICATION

A. Base Cabinet Construction:

1. Top Frame: Horizontal frame with pinned mortise and tenon joints; joined to cabinet side with 8-mm hardwood dowels on 32-mm centers. Includes 3/4-inch-thick x 2-3/4-inch-deep solid lumber front rail with solid hardwood lumber 3/4-inch-thick x 2-3/4-inch-deep side rails and back rails.
2. Divider Under Drawers: 3/4-inch-thick x 2-3/4-inch-deep front solid maple lumber cross rail, secured to cabinet sides with 8-mm hardwood dowels on 32-mm centers. On all-drawer cabinets where locks are indicated, provide 3/4" hardwood veneer core plywood panel of full width and depth with 3/8" solid maple edgeband on front edge to prevent access to other drawers.
3. Bottoms: 3/4-inch thick 7-ply hardwood plywood, joined to cabinet sides with 8-mm hardwood dowels on 32-mm centers.

4. Sub-Base: Separate and continuous (no cabinet body sides-to-floor), water resistant exterior grade plywood with concealed fastening to cabinet bottom. Ladder-type construction of front, back and intermediates to form a secure and level platform to which cabinets attach. Provide on surface of subbase, at exposed sides and ends, material to match cabinet material to ensure continuity where rubber base height may not cover due to floor shim. Typical
5. Tops, Dividers Under Drawers, and Bottoms: Securely glued and screwed under pressure to sides at assembly to ensure joint integrity and squareness.
6. Sides: 3/4-inch thick 7-ply hardwood veneer core plywood, faced with selected hardwood veneers for exposed surfaces and unselected but sound veneers for unexposed surfaces. Includes 3/8-inch-thick hardwood lumber nosing applied to exposed front edge of cabinet side. Where adjustable shelves required by specified manufacturer's catalog numbers, sides bored with 5 mm holes.
7. Backs: 1/4-inch-thick MDF core with hardwood veneer, secured to cabinet top and bottom and doweled into cabinet sides. Backs recessed 3/4-inch to permit accurate scribing to wall and 3/4" horizontal anchoring cleat behind back panel
8. Removable Backs: Where indicated by specified manufacturer's catalog numbers, backs retained in vertical cleats secured to cabinet sides to provide tight joints and convenient access to plumbing.
9. Shelves: 1-inch thick 9-ply hardwood veneer core plywood with 3/8-inch solid lumber edge band front edges. Shelves shall be set on double pin; plastic seismic locking shelf supports at 1 1/4" spacing. Shelf clips to be rated at 300 pounds per clip, 1200 pounds per shelf evenly distributed. Shelves shall be full depth in open units and 2" from rear face of doors in cupboard units.
10. Toe Space: 4-inches high x 3-1/4-inches deep with 3/4-inch-thick x 4-inch-high toe board, joined between cabinet sides with 8 mm hardwood dowels.
11. Drawers - Semi-Flush Radius Lipped:
 - a. Drawer Face: 3/4-inch-thick solid hardwood lumber core. Drawer fronts shall be machined to provide a radiused lip around the perimeter and provide a tight seal around the opening. Grain is horizontal
 - b. Drawer box: AWI Premium full height, 4-sided drawer boxes. Drawer box made from 1/2-inch-thick solid maple lumber and dovetailed at all four corners.
 - c. Bottoms: Shall be 1/4" MDF core plywood (1/2" hardwood veneer core plywood for drawers over 24" wide), fitted and secured into grooves in drawer box sub front, sides and back.
 - d. Interior Finish: Finished with the same laboratory grade finish as applied to the cabinet.

- e. Slides: Side mount, epoxy-coated drawer slides, providing at least 100 lbs. load capacity and incorporating positive stops. Provide progressive type slide with minimum 150 lbs. load capacity for file and paper drawers.

B. Wall Cabinet Construction:

1. Tops and Bottoms: 1-inch thick 9-ply hardwood veneer core plywood, joined to cabinet sides with 8 mm hardwood dowels on 32 mm centers. 3/8-inch-thick lumber hardwood nosing applied to exposed front edge.
2. Sides: 3/4-inch thick 7-ply hardwood plywood, faced with selected maple hardwood veneer on exposed and semi-exposed surfaces and unselected but sound veneer on unexposed surfaces. 3/8-inch-thick hardwood nosing applied to exposed front edge of cabinet side. Where adjustable shelves required, 5 mm holes bored in sides on 32 mm centers.
3. Backs: 1/4-inch-thick MDF core with hardwood veneers, secured to cabinet top and bottom, dadoed into cabinet sides, and recessed 3/4-inch to permit accurate scribing to wall and two 3/4" x 4" rear plywood rails, top and bottom, to rear exterior of the cabinet, to anchor through for attachment to wall.
4. Shelves: 1-inch thick 9-ply hardwood veneer core plywood with 3/8-inch-thick lumber hardwood nosing on front edge. Shelves shall be set on double pin, plastic seismic locking shelf supports at 1 1/4" spacing. Shelf clips to be rated at 300 pounds per clip, 1200 pounds per shelf evenly distributed. Shelves shall be full depth in open units and 2" from rear face of doors in cupboard units.

C. Cases:

1. Tops: Case tops shall be 1", 9 ply hardwood veneer core plywood edge banded on exposed edges with 3/8" solid lumber nosing and fastened to ends with 8mm fluted dowels. Tops Bottoms securely glued and screwed under pressure to sides at assembly to ensure joint integrity and unit squareness.
2. Bottoms: 3/4-inch thick 7-ply hardwood veneer core plywood joined to cabinet sides with 8 mm hardwood dowels. Bottoms securely glued and screwed under pressure to sides at assembly to ensure joint integrity and unit squareness.
3. Sides: 3/4-inch thick 7-ply hardwood veneer core plywood, faced with selected hardwood veneer on exposed surfaces and unselected but sound veneers on unexposed surfaces. 3/8-inch-thick hardwood nosing applied to front edge of cabinet side. When adjustable shelves required, 5 mm holes bored in sides.
4. Backs: Semi exposed backs of all tall cabinets shall be 1/2" MDF veneered hardwood plywood. Backs will be dadoed on the ends and will be glued, screwed into the top and bottom. Backs are recessed 3/4-inch to permit accurate scribing to wall and two 3/4" x 4" rear plywood rails, top and bottom, to rear exterior of the cabinet, to anchor through for attachment to wall.

5. Shelves: 1-inch thick 9-ply hardwood veneer core plywood with 3/8-inch-thick lumber hardwood nosing on front edge. Shelves shall be set on double pin; plastic seismic locking shelf supports at 1¼" spacing. Shelf clips to be rated at 300 pounds per clip, 1200 pounds per shelf evenly distributed. Shelves shall be full depth in open units and 2" from rear face of doors in cupboard units.
6. Toe Space: 4-inches high x 3-1/4-inches deep with 3/4-inch-thick x 4-inch-high toe board, joined between cabinet sides with 8 mm hardwood dowels.

D. Doors - Semi-Flush Radius Lipped:

1. Solid Doors

- a. Base and Wall Cabinets: 3/4-inch-thick with ¾" x 1-3/4" solid hardwood lumber perimeter frame and ¾" particle board core, lipped on all 4 edges and faced with hardwood veneer front and back. Grain is vertical.
- b. Tall Cases: 1-inch-thick with ¾" x 1-3/4" solid lumber perimeter frame and 1" particle board core, lipped on all 4 edges and faced with hardwood veneer front and back. Grain is vertical.

2. Hinged Glazed Doors:

- a. Hinged glass base and wall cabinet doors shall be fabricated of ¾" x 2 ¾" solid hardwood to match exposed veneer, using stile and rail construction. Glass shall be 6mm tempered.
- b. Tall case doors shall be fabricated of 1" x 2-3/4" solid maple hardwood. Doors shall be machined to match base cabinet doors. Doors shall have half reveal overlay. Glass shall be 6mm tempered.

- E. Filler Strips: Provide as needed to close spaces between cabinets and walls, ceilings, and indicated equipment. Fabricate from same material and with same finish as cabinets.

2.6 CASEWORK FINISH

- A. Wood Finishes: Varnish providing tough, hard properties to withstand most severe conditions and staining agents imparting clean, translucent appearance to wood substrate and enhance and improve natural graining in face without suggestion of masking or hiding. Finished film provides mellow, smooth texture.

1. Surface Preparation: All surfaces thoroughly sanded with fine abrasive not coarser than 3/0 Garnet finishing paper, achieving absolute cleanliness before finishing coat application. All wood flour and abrasive particles removed with dry compressed air and all areas wiped with tack rag.

2. Sealing: Synthetic resin based sealer applied to all surfaces of drawer, cabinet doors, exposed surface and other small sections where complete sealing of edges necessary to prevent moisture absorption. Remainder of cabinet sprayed with sealer after application to specific surfaces. Sealer air-dried within 20 minutes to permit light scuff sanding with 5/0 Garnet finishing paper and subsequently thoroughly dusted.
3. Stain: Pigmented stain consisting of non-fading and non-bleeding colors, ground in suitable vehicle, permitting blending in proportions required to produce color selected by Architect from manufacturer's full range of standard and custom colors.
4. Top Coat: Varnish consisting of moisture of chlorinated polymers and co-polymers suitably compounded with oil modified alkyd resin and other resinous plasticizers in solution of aromatic and oxygenated solvents. Produces cured film gloss with range of 40-50 measured by 60-degree glossmeter. Rubbed effect accomplished by inorganic flattening agent and acid catalyst added prior to spraying to convert film to cured state. Thorough sanding of previous coating provided to promote inter-coat adhesion with careful dusting to remove all powdered finish and abrasive prior to final coating.
5. Chemical Resistance Properties –Oak Wood Veneer Casework
 - a. Spot Test to Evaporation
 - 1) Boiling Water.....No effect
 - 2) Ethyl Alcohol No effect
 - 3) Isopropyl Alcohol No effect
 - 4) Methyl Alcohol No Effect
 - 5) Xylol No effect
 - 6) Toluol.....No effect
 - 7) Naptha No effect
 - 8) Gasoline No effect
 - 9) Methyl Ethyl Ketone.....No effect
 - 10) Acetone No effect
 - 11) Chloroform.....No effect
 - 12) Formaldehyde No effect
 - 13) Ink No effect
 - b. Spot Test for One Hour
 - 1) 25 percent Sulfuric Acid No effect
 - 2) 70 percent Sulfuric Acid Film destroyed
 - 3) 20 percent Hydrochloric Acid (5 min.)... No effect
 - 4) 37 percent Hydrochloric Acid..... Very slight ring & stain
 - 5) 50 percent Nitric Acid..... Film destroyed
 - 6) 10 percent Sodium Hydroxide No effect
 - 7) 29 percent Ammonia..... No effect
 - 8) Iodine Slight stain
 - 9) Lipstick No effect
 - 10) Crayon..... No effect
 - 11) Catsup No effect
 - 12) Butter..... No effect

- 13) Oleo..... No effect
- 14) Mustard No effect
- 15) Grape Juice..... No effect
- 16) Coke or Pepsi Cola..... No effect
- 17) Vinegar..... No effect
- 18) Milk..... No effect

- c. Adhesion and Toughness: Attempts to separate various finish layers from each other and from wood with razor blade or sharp knife are extremely difficult or results in no separation of various layers.

2.7 CASEWORK HARDWARE AND ACCESSORIES

- A. Hardware, General: Unless otherwise indicated, provide manufacturer's standard satin-finish, commercial-quality, heavy-duty hardware.
 - 1. Use threaded metal or plastic inserts with machine screws for fastening to particleboard, except where hardware is through bolted from back side.
- B. Butt Hinges: Wrap-around type, 5-knuckle pin, heavy-duty institutional type with rounded ends, finished in either brushed chrome or black as directed by Architect and concealing hinge screws when door closed.
 - 1. Lipped Construction: 2-1/2-inches high x 0.072-inch thick.
 - 2. Offset kitchen cabinet type, plain butt hinges or hinges with removable pins not acceptable.
 - 3. 2 hinges provided on doors less than 36 inches high; 3 hinges provided on doors over 36 inches high and 4 hinges on doors over 60 inches high.
- C. Pulls: Solid nylon aluminum stainless-steel or chrome-plated brass wire pulls, fastened from back with two screws, 4 inches on center. For sliding doors, provide recessed stainless-steel or chrome-plated flush pulls. Provide two pulls for drawers more than 24 inches wide.
- D. Door Catches: Zinc-plated Powder-coated, nylon-roller spring catch or dual, self-aligning, permanent magnet catches. Provide two catches on doors more than 40 inches high.
- E. Adjustable Shelf Supports: Double pin, plastic seismic locking shelf supports at 1¼" spacing. Shelf clips to be rated at 300 pounds per clip, 1200 pounds per shelf evenly distributed. Provide submittal showing load rating compliance.
- F. Adjustable Wall Shelf Supports: Surface-type steel standards and steel shelf brackets, with epoxy powder-coated finish, complying with BHMA A156.9, Types B04102 and B04112.
- G. Countertop Support: type and style as called out on drawings.
- H. Grilles: Continuous brushed aluminum, satin aluminum, clear aluminum finished countertop grille and toe-kick grille for air filtration at fin tube locations and as shown on Drawings similar to "Model #CT-PP-3 (c'top)/ #CT-PP-0 (toe)Linear Diffuser" by Titus.

- I. Cable Tray: Continuous single sided, 4" x 4" cable tray. Secured to counter and cabinets as top and side panel mounted. Sim. to "Snake Tray 401 series.
- J. Spray Booth CIF SB Series, size as noted on drawings: 18 gage steel fully welded into rigid superstructure. All electrical devices shall be NEC/CEC Class 1, Div. 1 and 2, Group C, D Standard 894 compliant, in addition items noted below:
1. Provide with ADA base unit.
 2. Two air filters.
 3. Explosion proof light.
 4. Explosion proof switches
 5. Ceiling Enclosure by CIF, size as shown on drawings.
 6. Select color from manufacturers full range of colors
- K. ADA Safety Station CIF #X1041: in addition, items noted below:
1. Provide with ADA base unit.
 2. Emergency eye/face wash, 4 spray heads, lever handle and 13" bowl. Water Saver FE730
 3. 1 Emergency Shower, 10" shower head with pull rod. Water Saver ES643SSH
 4. Epoxy resin countertop.
 5. Provide 1 Drench Shower tester sim. to Bradley S19-330ST
- L. Fume Hood Unit Airfoil Bypass CIF APEX-air GP Series– 48" width unless noted on drawings: in addition, items noted below:
1. Provide with ADA base unit.
 2. T-8 Fluorescent light fixture with bulbs, accessed from outside of air chamber.
 3. Single pole, 115V, 20A light switch. CIF #FF200
 4. Stainless steel bottom sill
 5. Louvered front panel.
 6. Dished, epoxy resin countertop. CIF #FB841 with all machining for cupsink and running of services. Color to match rest of epoxy on project.
 7. 1-3" x 6" oval cupsink, epoxy resin
 8. 2 gases, 2, air, 2 vacuum services- provide cover plates for services not required. CIF #FF100-01CV and color coded indexed for service.
 9. 1 cold water gooseneck with vacuum breaker. CIF #FF120-01
 10. 2 GFI duplex, AC receptacles. CIF #FF225
 11. 1 manual starter switch with pilot light for blower unit (blower unit by others). 1hp/115-230 VAC. Heating element not included.
 12. Ceiling Enclosure, CIF FB79-48 Series with front access door for light service, size as shown on drawings.
 13. All fume hood electrical items will be prewired at the factory to a junction box located on the top of the fume hood.
 14. All plumbing services will be factory pre-plumbed to a location above or below the fume hood for final connection to others. Coordinate with service locations.
 15. Select color from manufacturers full range of colors.

2.8 COUNTERTOPS AND SILLS

A. Solid Surface:

1. Provide countertops with the following front and backsplash style: 1/2-inch thick, solid surface material on 3/4" substrate for 1-1/4" overall thickness
2. Splashes and sills: 1/2-inch thick, solid surface material or as detailed on drawings.
3. Fabrication: Fabricate tops in one piece on marine grade plywood with shop-applied edges unless otherwise indicated. Comply with solid-surface-material manufacturer's written instructions for adhesives, sealers, fabrication, and finishing. Solid Surface Material: Homogeneous solid sheets of filled plastic resin complying with ANSI SS1, Class A.
4. Fabricate with loose splashes for field assembly.
5. Adhesives: Adhesives shall not contain urea formaldehyde.
6. Fabricate stools and aprons in one piece, unless otherwise indicated. Comply with solid-surface-material manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
7. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Hanex Solid Surfaces.
 - b. Corian
 - c. LG Hi Macs
 - d. Formica Corporation.
 - e. Wilsonart International.
8. Colors and Patterns: As selected by Architect from manufacturer's full range.

2.9 LABORATORY ACCESSORIES

- A. Burette Rods: Aluminum or stainless-steel rods, 1/2 inch in diameter and 18 inches long, threaded on 1 end to fit tapered plug adapter for flush socket receptacle. Provide with tapered plug adapter and receptacle.
- B. Upright Rod Assembly and Metal Crossbar: Aluminum or stainless steel. Two vertical rods and 1 horizontal crossbar, 3/4 inch in diameter and 36 inches long, unless otherwise indicated: 2 flush socket receptacles and 2 crossbar clamps. Ends of vertical rods are tapered to fit receptacles; all other rod ends are rounded.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances, location of framing and reinforcements, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 CASEWORK INSTALLATION

- A. Grade: Install cabinets to comply with same grade as item to be installed.
- B. Install casework level, plumb, and true; shim as required, using concealed shims. Where casework abuts other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical.
- C. Utility-Space Framing: Secure to floor with two fasteners at each frame. Fasten to partition framing, wood blocking, or metal reinforcements in partitions and to base cabinets.
- D. Base Cabinets: Adjust top rails and subtops within 1/16 inch of a single plane. Fasten cabinets to utility-space framing, partition framing, wood blocking, or reinforcements in partitions with fasteners spaced not more than 24 inches o.c. Fasten adjacent cabinets together with joints flush, tight, and uniform. Align similar adjoining doors and drawers to a tolerance of 1/16 inch.
 - 1. Where base cabinets are installed away from walls, fasten to floor at toe space at not more than 24 inches o.c. and at sides of cabinets with not less than 2 fasteners per side.
- E. Wall Cabinets: Adjust fronts and bottoms within 1/16 inch of a single plane. Fasten to hanging strips, masonry, partition framing, blocking, or reinforcements in partitions. Fasten each cabinet through back, near top, at not less than 24 inches o.c. Align similar adjoining doors to a tolerance of 1/16 inch.
- F. Fasten cabinets to adjacent cabinets and to masonry, framing, wood blocking, or reinforcements in walls and partitions to comply with the AWI's, AWMAC's, and WI's "Architectural Woodwork Standards."
- G. Install hardware uniformly and precisely. Set hinges snug and flat in mortises unless otherwise indicated. Adjust and align hardware so moving parts operate freely and contact points meet accurately. Allow for final adjustment after installation.
- H. Adjust casework and hardware so doors and drawers operate smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer.

3.3 CLEANING

- A. Repair or remove and replace defective work as directed on completion of installation.
- B. Clean and dust finished surfaces, inside and out, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.
- C. Protect countertop surfaces during construction with 6-mil plastic or other suitable water-resistant covering. Tape to underside of countertop at minimum of 48 inches o.c.

END OF SECTION 12 32 13

SECTION 12 56 51 - LIBRARY FURNITURE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Wood-case library shelving.
 - 2. Circulation desk assembly.
 - 3. Library furniture including:
 - a. Computer work stations.
 - b. OPAC (Online Public Access Catalog).
 - c. Tables.
 - d. Carrels.
 - e. Display furniture.
 - 4. Seating.

1.3 SUBMITTALS, GENERAL

- A. General: Submit all action submittals (except Samples for Verification) and informational submittals required by this Section concurrently.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for library furniture and accessories.
 - 1. Wood-case shelving.
 - 2. Wood-faced circulation desk assembly.
 - 3. Computer work stations.
 - 4. OPAC.
 - 5. Tables.
 - 6. Carrels.
 - 7. Carrel tables.
 - 8. Dictionary stands.
 - 9. Atlas stands.

10. Newspaper racks.
11. Magazine racks.
12. Display tables.
13. Display cases.
14. Revolving dictionary stands.
15. Display kiosks.
16. Lounge chairs.
17. Task chairs.
18. Student chairs.

B. Shop Drawings:

1. Include plans, elevations, sections, and details.
2. Show clear-aisle widths from face of units.
3. Detail fabrication and installation of library shelving systems including methods of anchoring to building structure at locations recommended by manufacturer.

C. Samples for Initial Selection: For units with factory-applied finishes, 6 inches in size.

D. Samples for Verification: For the following products:

1. One full-size finished section of wood-faced circulation desk assembly complete with hardware, doors, and drawers; including countertop.
2. One full-sized end panel assembly of style specified.
3. Table leg assembly.
4. Student chair.
5. Electrical service fittings.

1.5 INFORMATIONAL SUBMITTALS

- A. Seismic Design Calculations: For seismic design of library shelving systems including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- B. Qualification Data: For Installer.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For library stack systems to include in maintenance manuals.
- B. Warranty: Each product warranty.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Source Limitations: Obtain library furniture through one source from a single manufacturer, unless noted otherwise.

C. Fire-Test-Response Characteristics of Upholstered Chairs:

1. Fabric: Class 1 according to U.S. Department of Commerce (DOC) CS 191 and 16 CFR 1610.61, tested according to California Technical Bulletin 117.
2. Padding: Comply with California Technical Bulletin 117.
3. Full-Scale Fire Test: Comply with California Technical Bulletin 133.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Product Options: Drawings indicate size, profiles, and dimensional requirements of library furniture and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

1. Do not modify requirements, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

F. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless such deviations are specifically approved by Architect in writing.
2. Provide mock-ups for the following:
 - a. One full-size wood case library shelving.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver library furniture only after painting, utility roughing-in, and similar operations that could damage, soil, or deteriorate library furniture have been completed in installation areas. If library furniture must be stored in other than installation areas, store only in areas where environmental conditions meet requirements specified in "Project Conditions" Article.
- B. Keep finished surfaces covered with polyethylene film or other protective covering during handling and installation.

1.9 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install library furniture until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at occupancy levels during the remainder of the construction period.
- B. Field Measurements: Verify actual dimensions of construction contiguous with library furniture by field measurements before fabrication. Indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Library shelving systems shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

2.2 WOOD-CASE SHELVING

- A. Wood-Case Library Shelving: Shelving designed for library use and consisting of base frame and full end, top, and back panels, with end panels made to receive pins to support adjustable shelves.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Worden Company; Pin-Fast Shelving or comparable product.
- B. Wood Case Library Shelving: Shelving designed for library use and consisting of full end, top, and back panels, with end panels made to receive pins to support adjustable shelves.
 - 1. Configuration: Starter/adder units.
- C. Vertical Panels: Panels consisting of lumber-core veneer panels, 1-inch-thick, with solid-wood banding. Provide two rows of 8 mm holes at 32 mm intervals for shelf support pins on one side of end panels and both sides of intermediate panels.
- D. Base Frames: Lumber-core veneer panel external toe kick; particleboard with thermally fused melamine internal and back toe kicks; 4 inches high; designed to support bottom shelf and fabricated to attach and tie together vertical panels.
- E. Wood Shelves: Panels consisting of solid hardwood boards glued together, 3/4-inch-thick, with 2-inch solid-wood nosing strip, and grooved on underside to rest securely on supporting pins.
- F. Cornice Tops: 3/4-inch-thick, particleboard-core veneer panel banded with solid hardwood fasciae on one side for single-faced units and on two sides for double-faced units, fabricated to attach and tie together vertical panels.
- G. Back and Divider Panels: Veneer-core, veneer-faced panels, 1/4-inch-thick.
- H. Bookstack Units:
 - 1. Type: Single-faced units.
 - 2. Width: 36 inches.
 - 3. Height and Number of Shelves:
 - a. 42 inches; Three adjustable shelves; one base shelf.
 - b. 63 inches; Four adjustable shelves; one base shelf.
 - c. 82 inches; five adjustable shelves; one base shelf.
 - d. 96 inches; six adjustable shelves; one base shelf.

4. Shelf Depth: 12 inches nominal.
5. Shelf Style:
 - a. Flat, unless noted otherwise.
 - b. Adjustable divider; where indicated.
 - 1) Notch shelf bottom for dividers.
 - c. Pivot type periodical; for use in 12-inch-deep units, where indicated.
 - 1) Provide retaining rail, and adjustable pins for access to stored back issues.
 - d. Hinged periodical; for use in 16-inch-deep units, where indicated.
 - 1) Provide retaining rail, and allow for shelves to be self-storing in open position.

I. Accessories:

1. Adjustable Shelf Dividers: One-piece shelf partitions, with hooks or tabs to fit in slots in divider shelves.
 - a. Provide three per adjustable divider shelf.
2. Shelf Label Holders: Clear plastic, 5 inches long, designed to snap over adjustable shelves.
 - a. Provide one per shelf.
3. Card Holders: Sized to hold 3-by-5-inch cards.
 - a. Provide one for single-faced units and two for double-faced units at each end of each range.
4. Glass Doors: 1/4-inch-thick clear tempered glass for display cases; bypassing roller track system; finger pull and lock.

2.3 WOOD-FACED CIRCULATION DESK ASSEMBLY

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Worden Company; CRI Desk System.
- B. Circulation Desk Assembly: Consisting of work surface; end, intermediate and back panels; and features as indicated.
 1. Work Surfaces: Plastic-laminate sheet, bonded to both sides of 1-1/4-inch particleboard.
 - a. Plastic Laminate for Work Surfaces: High-pressure laminate, 0.050-inch-thick.
 - b. Plastic Laminate for Backing: Backing sheet, 0.028-inch-thick.

- c. Provide solid-wood edging on front and back edges of work surface.
- 2. End Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with solid-wood banding on all four edges. Provide adjustable glides.
- 3. Intermediate Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with solid-wood banding on all four edges. Provide adjustable glides.
- 4. Front Panels: 3/4-inch-thick, particleboard-core veneer-faced panel with solid-wood banding on bottom edge.
- 5. Shelves: 3/4-inch-thick, particleboard-core veneer-faced panel with solid-wood banding on face and back edges.
- 6. Hinged Doors: 3/4-inch-thick, particleboard-core veneer-faced panel with solid-wood banding on all four edges. Attach with concealed hinges.
- 7. Drawers: 3/4-inch-thick, particleboard-core veneer-faced panel with solid-wood banding on all four edges; veneer-core plywood drawer box; pull; side-mounted, ball bearing extension drawer slides.
 - a. Standard Drawer Slides: 60 pound capacity minimum.
 - b. File Drawer Slides: 135 pound capacity minimum; full-extension type.

2.4 LIBRARY FURNITURE-TYPE TR

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Worden Company; Teres R Series.
- B. Computer Work Stations: Consisting of work surface; shelves as indicated; end, intermediate and back panels; on legs, with vertical wire management.
 - 1. Work Surfaces: Plastic-laminate sheet, bonded to both sides of 1-1/4-inch lumber-core.
 - a. Plastic Laminate for Work Surfaces: High-pressure laminate, 0.050-inch-thick.
 - b. Plastic Laminate for Backing: Backing sheet, 0.028-inch-thick.
 - c. Provide solid-wood edging on front edge of work surface.
 - d. Provide space for cord drop at back of work surface.
 - 2. Shelves: 1-inch-thick, particleboard-core veneer-faced panel with solid-wood banding.
 - a. J-Channel Shelves: 3/4-inch-thick, thermally fused laminate-clad particleboard-core panel with PVC edge banding.
 - 3. Panels: 3/4-inch-thick, particleboard-core veneer-faced panel with solid-wood banding.
 - 4. Legs: 1-1/2-inch square solid-wood, with radiused edges and adjustable glides.
 - 5. Vertical Wire Management: Provide wireway between work surface and J-channel shelf.

- C. OPAC: Consisting of work surfaces; lid; shelves as indicated; end, intermediate and back panels; full and half hex carrels, with vertical wire management.
1. Work Surfaces: Plastic-laminate sheet, bonded to both sides of 1-1/4-inch particleboard.
 - a. Plastic Laminate for Work Surfaces: High-pressure laminate, 0.050-inch-thick.
 - b. Plastic Laminate for Backing: Backing sheet, 0.028-inch-thick.
 - c. Provide solid-wood edging on front edge of work surface.
 - d. Provide space for cord drop at back of work surface.
 2. Lids: Plastic-laminate sheet, bonded to both sides of 1-3/16-inch particleboard.
 - a. Plastic Laminate for Work Surfaces: High-pressure laminate, 0.050-inch-thick.
 - b. Plastic Laminate for Backing: Backing sheet, 0.028-inch-thick.
 3. Paper and Display Shelves: 3/4-inch-thick, particleboard-core veneer-faced panel with solid-wood banding.
 4. Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with solid-wood banding and adjustable glides.
 5. Triangular Posts: 1-1/2-inch wide on each of three sides, powder coated extruded aluminum, with top cap and adjustable glides.
 6. Vertical Wire Management: Provide wireway between work surface and paper shelf.
 7. Grommets: Provide 12 inch by 1-3/4-inch plastic paper grommet in each section of work surface.
- D. Tables: Consisting of tops, legs, and features as indicated.
1. Tops for Computer/Reference and Library Tables: Plastic-laminate sheet, bonded to both sides of 1-1/4-inch lumber-core.
 - a. Plastic Laminate for Tops: High-pressure laminate, 0.050-inch-thick.
 - b. Plastic Laminate for Backing: Backing sheet, 0.028-inch-thick.
 - c. Provide solid-wood edging at perimeter edges of tops.
 - d. Provide trim/apron rail at perimeter of tops.
 2. Tops for Index Tables: Plastic-laminate sheet, bonded to both sides of 1-1/4-inch particleboard.
 - a. Plastic Laminate for Tops: High-pressure laminate, 0.050-inch-thick.
 - b. Plastic Laminate for Backing: Backing sheet, 0.028-inch-thick.
 - c. Provide solid-wood edging at perimeter edges of tops.
 - d. Provide trim/apron rail at perimeter of tops.
 3. Legs: 2-1/4-inch square glued-up solid-wood, with radiused edges and adjustable glides.

4. Table Types:

- a. Computer/Reference Tables: Provide with solid-wood stretcher assembly connecting legs, table racks of 1-inch-thick, particleboard-core veneer-faced panel with solid-wood banding, and three-compartment call-slip boxes.
- b. Index Tables: Provide with index racks of 1-inch-thick, particleboard-core veneer-faced panel with solid-wood banding.
- c. Library Tables: Provide in configurations indicated.
 - 1) Provide additional table top support for tables 48 inches wide or 60 inches long, and greater.

E. Carrels:

- 1. Modular Carrels: Consisting of work surface; shelves as indicated; end, intermediate and back panels; on legs.
 - a. Work Surfaces: Plastic-laminate sheet, bonded to both sides of 1-1/4-inch particleboard.
 - 1) Plastic Laminate for Work Surfaces: High-pressure laminate, 0.050-inch-thick.
 - 2) Plastic Laminate for Backing: Backing sheet, 0.028-inch-thick.
 - 3) Provide solid-wood edging on front edge of work surface.
 - b. Shelves: 3/4-inch-thick, particleboard-core veneer-faced panel with solid-wood banding.
 - c. Panels: 3/4-inch-thick, particleboard-core veneer-faced panel with solid-wood banding.
 - d. Legs: 1-1/2-inch square solid-wood, with radiused edges and adjustable glides.

F. Carrel Tables: Consisting of tops, legs, and features as indicated.

- 1. Tops: Plastic-laminate sheet, bonded to both sides of 1-1/4-inch particleboard.
 - a. Plastic Laminate for Tops: High-pressure laminate, 0.050-inch-thick.
 - b. Plastic Laminate for Backing: Backing sheet, 0.028-inch-thick.
 - c. Provide solid-wood edging at all four edges of tops.
 - d. Provide trim rail at all four edges of tops.
- 2. Legs: 2-1/4-inch square glued-up solid-wood, with radiused edges and adjustable glides.
- 3. Racks: 3/4-inch-thick, particleboard-core veneer-faced panel with solid-wood banding.

G. Display Furniture:

1. Dictionary Stands: Consisting of sloped top; shelves as indicated; back and end panels.
 - a. Tops: Plastic-laminate sheet, bonded to 1-1/4-inch backing.
 - 1) Plastic Laminate for Tops: High-pressure laminate, 0.050-inch-thick.
 - 2) Provide self-edge for back and retaining strip at front.
 - b. Shelves: 3/4-inch-thick, particleboard-core veneer-faced panel with solid-wood banding.
 - c. End Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with solid-wood banding and adjustable glides.
 - d. Back Panels: 3/4-inch-thick, particleboard-core veneer-faced panel with solid-wood banding.
2. Atlas Stands: Consisting of sloped top; pull-out shelves as indicated; back and end panels.
 - a. Tops: Plastic-laminate sheet, bonded to 1-1/4-inch backing.
 - 1) Plastic Laminate for Tops: High-pressure laminate, 0.050-inch-thick.
 - 2) Provide self-edge for back and retaining strip at front.
 - b. Shelves: 3/4-inch-thick, particleboard-core veneer-faced panel with solid-wood banding; with full-extension ball bearing slides with stops.
 - c. End Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with solid-wood banding and adjustable glides.
 - d. Back Panels: 3/4-inch-thick, particleboard-core veneer-faced panel with solid-wood banding.
3. Newspaper Racks: Consisting of top frame to hold ten newspaper display rods; back and end panels.
 - a. Top Frames: 1-1/4-inch thick solid-wood open frame, notched for display rods.
 - b. Display Rods: Solid wood rods with rubber retainer rings at ends.
 - c. Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with solid-wood banding.
4. Magazine Racks: Consisting of six sloped display shelves, with capacity for approximately 40 magazines; back and end panels.
 - a. End Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with solid-wood banding and adjustable glides.
 - b. Back Panels: 3/4-inch-thick, particleboard-core veneer-faced panel with solid-wood banding.

5. Display Tables: Consisting of metal-framed glass case with tackable bottom surface, mounted to table with top, legs, and features as indicated.
 - a. Metal Display Case Frames: Extruded aluminum in dark bronze finish; top of case hinged with continuous piano-type hinge and equipped with two point lock and lid supports.
 - b. Glass: 3/16-inch-thick clear tempered glass at sides and top.
 - c. Tackable Surfaces: Clad with beige-colored fabric.
 - d. Tops: Plastic-laminate sheet, bonded to both sides of 1-1/4-inch particleboard.
 - 1) Plastic Laminate for Tops: High-pressure laminate, 0.050-inch-thick.
 - 2) Plastic Laminate for Backing: Backing sheet, 0.028-inch-thick.
 - 3) Provide solid-wood edging at all four edges of tops.
 - 4) Provide trim/apron rail at all four edges of tops.
 - e. Legs: 2-1/4-inch square glued-up solid-wood, with radiused edges and adjustable glides.
6. Display Cases: Consisting of metal-framed glass case, with adjustable glass shelving as indicated; back and bottom panels; and mounted to flush panel base.
 - a. Metal Display Case Frames: Extruded aluminum in dark bronze finish.
 - b. Glass Case: 3/16-inch-thick clear tempered glass at sides and top; 3/16-inch-thick clear tempered glass sliding doors at front, equipped with lock.
 - c. Glass Shelving: Two 1/4-inch-thick clear tempered glass shelves, with supports; adjustable on 1-inch centers.
 - d. Back and Bottom Panels: 7/16-inch-thick, particleboard-core veneer-faced panel.
 - e. Bases: 3/4-inch-thick, veneer-core veneer-faced panel.
7. Revolving Dictionary Stands: Consisting of sloped rotating top on base.
 - a. Tops: 3/4-inch-thick, particleboard-core veneer-faced panel with solid-wood banding.
 - 1) Provide retaining strip at front.
 - 2) Provide ball bearing swivel mechanism.
 - b. Bases: 3/4-inch-thick solid-wood.

2.5 LIBRARY FURNITURE-TYPE 7000

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Worden Company; Academy Series.
- B. Computer Work Stations: Consisting of work surface; shelves as indicated; end, intermediate, and back panels; with vertical wire management.

1. Work Surfaces: Plastic-laminate sheet, bonded to both sides of 1-1/4-inch particleboard.
 - a. Plastic Laminate for Work Surfaces: High-pressure laminate, 0.050-inch-thick.
 - b. Plastic Laminate for Backing: Backing sheet, 0.028-inch-thick.
 - c. Provide solid-wood edging on front edge of work surface.
 - d. Provide space for cord drop at back of work surface.
 2. Bottom Shelves: 3/4-inch-thick, particleboard-core veneer-faced panel with solid-wood banding.
 - a. J-Channel Shelves: 3/4-inch-thick, thermally fused laminate-clad particleboard-core panel with PVC edge banding.
 3. End Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with 1-3/4-inch by 2-1/2-inch solid-wood frame around all four edges, with decorative wood slats. Provide adjustable glides.
 4. Intermediate Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with 1-3/16-inch by 2-1/2-inch solid-wood banding at top and bottom edges and solid-wood banding on vertical edges. Provide adjustable glides.
 5. Back Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with 1-3/16-inch by 2-1/4-inch solid-wood banding at top edge and solid-wood banding on bottom edge.
 6. Vertical Wire Management: Provide wireway between work surface and J-channel shelf.
- C. OPAC: Consisting of work surfaces; lid; shelves as indicated; end, intermediate and back panels; full and half hex carrels, with vertical wire management.
1. Work Surfaces: Plastic-laminate sheet, bonded to both sides of 1-1/4-inch particleboard.
 - a. Plastic Laminate for Work Surfaces: High-pressure laminate, 0.050-inch-thick.
 - b. Plastic Laminate for Backing: Backing sheet, 0.028-inch-thick.
 - c. Provide solid-wood edging on front edge of work surface.
 - d. Provide space for cord drop at back of work surface.
 2. Lids: Plastic-laminate sheet, bonded to both sides of 1-1/4-inch particleboard.
 - a. Plastic Laminate for Work Surfaces: High-pressure laminate, 0.050-inch-thick.
 - b. Plastic Laminate for Backing: Backing sheet, 0.028-inch-thick.
 3. Paper and Display Shelves: 3/4-inch-thick, particleboard-core veneer-faced panel with solid-wood banding.
 4. End Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with 1-3/4-inch by 2-1/2-inch solid-wood frame at top and bottom edges and solid-wood banding on vertical edges. Provide adjustable glides.
 5. Intermediate Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with 1-3/16-inch by 2-1/2-inch wood frame at top and bottom edges and solid-wood banding on vertical edges. Provide adjustable glides.

6. Back Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with 1-3/16-inch by 2-1/2-inch solid-wood banding at top and bottom edges.
 7. Triangular Posts: 1-1/2-inch wide on each of three sides, powder coated extruded aluminum, with top cap and adjustable glides.
 8. Vertical Wire Management: Provide wireway between work surface and paper shelf.
 9. Grommets: Provide 12 inch by 1-3/4-inch plastic paper grommet in each section of work surface.
- D. Tables: Consisting of tops, end panels and frames, and features as indicated.
1. Tops: Plastic-laminate sheet, bonded to both sides of 1-1/4-inch particleboard.
 - a. Plastic Laminate for Tops: High-pressure laminate, 0.050-inch-thick.
 - b. Plastic Laminate for Backing: Backing sheet, 0.028-inch-thick.
 - c. Provide solid-wood edging at long perimeter edges of tops.
 2. Table Types:
 - a. Index Tables: Provide with index racks of 1-inch-thick, particleboard-core veneer-faced panel with solid-wood banding.
 - 1) End Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with 1-3/4-inch by 2-1/2-inch solid-wood frame around all four edges, with decorative wood slats. Provide adjustable glides.
 - 2) Keels: Two 1-inch-thick, lumber-core veneer-faced panels attached to tops and end panels.
 - b. Library Tables: Provide in configurations indicated.
 - 1) End Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with 1-3/4-inch by 2-1/2-inch solid-wood frame around all four edges, with decorative wood slats. Provide adjustable glides.
- E. Carrels:
1. Modular Carrels: Consisting of work surface; shelves as indicated; end, intermediate, and back panels.
 - a. Work Surfaces: Plastic-laminate sheet, bonded to 1-1/4-inch particleboard.
 - 1) Plastic Laminate for Work Surfaces: High-pressure laminate, 0.050-inch-thick.
 - 2) Provide solid-wood edging on front edge of work surface.
 - b. Shelves: 1-inch-thick, particleboard-core veneer-faced panel with solid-wood banding.

- c. End Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with 1-3/4-inch by 2-1/2-inch solid-wood frame around all four edges, with decorative wood slats. Provide adjustable glides.
- d. Intermediate Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with 1-3/16-inch by 2-1/2-inch wood frame at top and bottom edges and solid-wood banding on vertical edges. Provide adjustable glides.
- e. Back Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with 1-3/16-inch by 2-1/4-inch solid-wood banding at top edge and solid-wood banding on bottom edge.

F. Display Furniture:

- 1. Dictionary Stands: Consisting of sloped top; shelves as indicated; and end panels.
 - a. Tops: Plastic-laminate sheet, bonded to backing.
 - 1) Plastic Laminate for Tops: High-pressure laminate, 0.050-inch-thick.
 - 2) Provide retaining strip at front.
 - b. Shelves: 3/4-inch-thick, particleboard-core veneer-faced panel with solid-wood banding.
 - c. End Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with 1-3/4-inch by 2-1/2-inch solid-wood frame around all four edges, with decorative wood slats. Provide adjustable glides.
- 2. Atlas Stands: Consisting of sloped top; pull-out shelves as indicated; back and end panels.
 - a. Tops: Plastic-laminate sheet, bonded to backing.
 - 1) Plastic Laminate for Tops: High-pressure laminate, 0.050-inch-thick.
 - 2) Provide retaining strip at front.
 - b. Shelves: 3/4-inch-thick, particleboard-core veneer-faced panel with solid-wood banding; with full-extension ball bearing slides with stops.
 - c. End Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with 1-3/4-inch by 2-1/2-inch solid-wood frame around all four edges, with decorative wood slats. Provide adjustable glides.
 - d. Back Panels: 3/4-inch-thick, particleboard-core veneer-faced panel with solid-wood banding.
- 3. Newspaper Racks: Consisting of top frame to hold ten newspaper display rods; and end panels.
 - a. Top Frames: Solid wood open frame, notched for display rods.
 - b. Display Rods: Solid wood rods with rubber retainer rings at ends.

- c. End Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with 1-3/4-inch by 2-1/2-inch solid-wood frame around all four edges, with decorative wood slats. Provide adjustable glides.
- 4. Display Table: Consisting of metal-framed glass case with tackable bottom surface, mounted to table with top, end panels, and features as indicated.
 - a. Metal Display Case Frames: Extruded aluminum in dark bronze finish; top of case hinged with continuous piano-type hinge and equipped with two point lock and lid supports.
 - b. Glass: 3/16-inch-thick clear tempered glass at sides and top.
 - c. Tackable Surfaces: Clad with beige-colored fabric.
 - d. Tops: Plastic-laminate sheet, bonded to 1-1/4-inch particleboard.
 - 1) Plastic Laminate for Tops: High-pressure laminate, 0.050-inch-thick.
 - 2) Provide solid-wood edging at long edges of tops.
 - e. End Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with 1-3/4-inch by 2-1/2-inch solid-wood frame around all four edges, with decorative wood slats. Provide adjustable glides.

2.6 LIBRARY FURNITURE-TYPE 5000

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Worden Company; Tempus Collection.
- B. Computer Work Stations: Consisting of work surface; shelves as indicated; end, intermediate, and back panels; with vertical wire management.
 - 1. Work Surfaces: Plastic-laminate sheet, bonded to both sides of 1-1/4-inch particleboard.
 - a. Plastic Laminate for Work Surfaces: High-pressure laminate, 0.050-inch-thick.
 - b. Plastic Laminate for Backing: Backing sheet, 0.028-inch-thick.
 - c. Provide solid-wood edging on front edge of work surface.
 - d. Provide space for cord drop at back of work surface.
 - 2. Bottom Shelves: 3/4-inch-thick, particleboard-core veneer-faced panel with solid-wood banding.
 - a. J-Channel Shelves: 3/4-inch-thick, thermally fused laminate-clad particleboard-core panel with PVC edge banding.
 - 3. End Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with 1-3/16-inch by 3-inch solid-wood base and solid-wood banding around other edges, with decorative features as indicated by product line noted. Provide adjustable glides.

4. Intermediate Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with 1-3/16-inch by 3-inch base and solid-wood banding around other edges, with decorative features as indicated by product line noted. Provide adjustable glides.
 5. Back Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with solid-wood banding at top and bottom edges.
 6. Vertical Wire Management: Provide wireway between work surface and bottom shelf.
- C. OPAC: Consisting of work surfaces; lid; shelves as indicated; end, intermediate and back panels; full and half hex carrels, with vertical wire management.
1. Work Surfaces: Plastic-laminate sheet, bonded to both sides of 1-1/4-inch particleboard.
 - a. Plastic Laminate for Work Surfaces: High-pressure laminate, 0.050-inch-thick.
 - b. Plastic Laminate for Backing: Backing sheet, 0.028-inch-thick.
 - c. Provide solid-wood edging on front edge of work surface.
 - d. Provide space for cord drop at back of work surface.
 2. Lids: Plastic-laminate sheet, bonded to both sides of 1-1/4-inch particleboard.
 - a. Plastic Laminate for Work Surfaces: High-pressure laminate, 0.050-inch-thick.
 - b. Plastic Laminate for Backing: Backing sheet, 0.028-inch-thick.
 3. Paper Shelves: 3/4-inch-thick, particleboard-core veneer-faced panel with solid-wood banding.
 4. End Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with 1-3/16-inch by 3-inch solid-wood base and solid-wood banding around other edges, with decorative features as indicated by product line noted. Provide adjustable glides.
 5. Intermediate Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with 1-3/16-inch by 3-inch base and solid-wood banding around other edges, with decorative features as indicated by product line noted. Provide adjustable glides.
 6. Back Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with solid-wood banding at top and bottom edges.
 7. Triangular Posts: 1-1/2-inch wide on each of three sides, powder coated extruded aluminum, with top cap and adjustable glides.
 8. Vertical Wire Management: Provide wireway between work surface and bottom shelf.
 9. Grommets: Provide 12 inch by 1-3/4-inch plastic paper grommet in each section of work surface.
- D. Tables: Consisting of tops, end panels and legs, and features as indicated.
1. Tops: Plastic-laminate sheet, bonded to both sides of 1-1/4-inch particleboard.
 - a. Plastic Laminate for Tops: High-pressure laminate, 0.050-inch-thick.

- b. Plastic Laminate for Backing: Backing sheet, 0.028-inch-thick.
- c. Provide solid-wood edging at long perimeter edges of tops.

2. Table Types:

- a. Computer/Reference Tables: Provide with table racks of 3/4-inch-thick, particleboard-core veneer-faced panel with solid-wood banding and three-compartment call-slip boxes.
 - 1) End Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with 1-3/16-inch by 3-inch solid-wood base and solid-wood banding around other edges, with decorative features as indicated by product line noted. Provide adjustable glides.
- b. Index Tables: Provide with index racks of 1-inch-thick, particleboard-core veneer-faced panel with solid-wood banding.
 - 1) End Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with 1-3/16-inch by 3-inch solid-wood base and solid-wood banding around other edges, with decorative features as indicated by product line noted. Provide adjustable glides.
 - 2) Keels: 1-inch-thick, lumber-core veneer-faced panels attached to tops and end panels.
- c. Library Tables: Provide in configurations indicated.
 - 1) End Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with 1-3/16-inch by 3-inch solid-wood base and solid-wood banding around other edges, with decorative features as indicated by product line noted. Provide adjustable glides.
 - a) Keels: 1-inch-thick, lumber-core veneer-faced panels attached to tops and end panels.
 - 2) Legs: 2-3/8-inch square glued-up solid-wood legs, with radiused edges and adjustable glides.
 - a) Aprons: 3/4-inch-thick solid-wood, with decorative features as indicated by product line.

E. Carrels:

- 1. Modular Carrels: Consisting of work surface; shelves as indicated; end, intermediate, and back panels.
 - a. Work Surfaces: Plastic-laminate sheet, bonded to 1-1/4-inch particleboard.
 - 1) Plastic Laminate for Work Surfaces: High-pressure laminate, 0.050-inch-thick.

- 2) Plastic Laminate for Backing: Backing sheet, 0.028-inch-thick.
 - 3) Provide solid-wood edging on front edge of work surface.
- b. Shelves: 1-inch-thick, particleboard-core veneer-faced panel with solid-wood banding.
 - c. End Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with 1-3/16-inch by 3-inch solid-wood base and solid-wood banding around other edges, with decorative features as indicated by product line noted. Provide adjustable glides.
 - d. Intermediate Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with 1-3/16-inch by 3-inch solid-wood base and solid-wood banding around other edges, with decorative features as indicated by product line noted. Provide adjustable glides.
 - e. Back Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with solid-wood banding at top and bottom edges.
 - f. Quad Posts: 1-3/16-inch square solid-wood post.

F. Display Furniture:

1. Dictionary Stands: Consisting of sloped top; shelves as indicated; and end panels.
 - a. Tops: Plastic-laminate sheet, bonded to 3/4-inch particleboard.
 - 1) Plastic Laminate for Tops: High-pressure laminate, 0.050-inch-thick.
 - 2) Provide retaining strip at front.
 - b. Shelves: 3/4-inch-thick, particleboard-core veneer-faced panel with solid-wood banding.
 - c. End Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with 1-3/16-inch by 3-inch solid-wood base and solid-wood banding around other edges, with decorative features as indicated by product line noted. Provide adjustable glides.
2. Atlas Stands: Consisting of sloped top; pull-out shelves as indicated; back and end panels.
 - a. Tops: Plastic-laminate sheet, bonded to 3/4-inch particleboard.
 - 1) Plastic Laminate for Tops: High-pressure laminate, 0.050-inch-thick.
 - 2) Provide retaining strip at front.
 - b. Shelves: 3/4-inch-thick, particleboard-core veneer-faced panel with solid-wood banding; with full-extension ball bearing slides with stops.
 - c. End Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with 1-3/16-inch by 3-inch solid-wood base and solid-wood banding around other edges, with decorative features as indicated by product line noted. Provide adjustable glides.

3. Newspaper Racks: Consisting of top frame to hold ten newspaper display rods; and end panels.
 - a. Top Frames: Solid wood open frame, notched for display rods.
 - b. Display Rods: Solid wood rods with rubber retainer rings at ends.
 - c. End Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with 1-3/16-inch by 3-inch solid-wood base and solid-wood banding around other edges, with decorative features as indicated by product line noted. Provide adjustable glides.
4. Display Tables: Consisting of metal-framed glass case mounted to table with top, end panels, and features as indicated.
 - a. Metal Display Case Frames: Extruded aluminum in dark bronze finish; top of case hinged with continuous piano-type hinge and equipped with two point lock and lid supports.
 - b. Glass: 3/16-inch-thick clear tempered glass at sides and top.
 - c. Tops: Plastic-laminate sheet, bonded to 1-1/4-inch particleboard.
 - 1) Plastic Laminate for Tops: High-pressure laminate, 0.050-inch-thick.
 - 2) Provide solid-wood edging at long edges of tops.
 - d. End Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with 1-3/16-inch by 3-inch solid-wood base and solid-wood banding around other edges, with decorative features as indicated by product line noted. Provide adjustable glides.

2.7 LIBRARY FURNITURE-TYPE D

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Diametron/Diametrix Series by The Worden Company.
- B. Computer Work Stations: Consisting of work surface; shelves as indicated; end, intermediate, and back panels; with vertical wire management.
 1. Work Surfaces: Plastic-laminate sheet, bonded to both sides of 1-1/4-inch particleboard.
 - a. Plastic Laminate for Work Surfaces: High-pressure laminate, 0.050-inch-thick.
 - b. Plastic Laminate for Backing: Backing sheet, 0.028-inch-thick.
 - c. Provide solid-wood edging on front edge of work surface.
 - d. Provide space for cord drop at back of work surface.
 2. Shelves: 3/4-inch-thick, particleboard-core veneer-faced panel with solid-wood banding.
 - a. J-Channel Shelves: 3/4-inch-thick, thermally fused laminate-clad particleboard-core panel with PVC edge banding.
 3. End Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with solid-wood banding at top, bottom, and front edges.

4. Intermediate Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with solid-wood banding at top, bottom, and front edges.
 5. Back Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with solid-wood banding at all edges.
 6. Posts: 1-1/2-inch diameter epoxy coated, steel tube, with top cap and adjustable glides.
 7. Vertical Wire Management: Provide wireway between work surface and shelf.
- C. OPAC: Consisting of work surfaces; lid; shelves as indicated; end, intermediate and back panels; full and half hex carrels, with vertical wire management.
1. Work Surfaces: Plastic-laminate sheet, bonded to both sides of 1-1/4-inch particleboard.
 - a. Plastic Laminate for Work Surfaces: High-pressure laminate, 0.050-inch-thick.
 - b. Plastic Laminate for Backing: Backing sheet, 0.028-inch-thick.
 - c. Provide solid-wood edging on front edge of work surface.
 - d. Provide space for cord drop at back of work surface.
 2. Lids: Plastic-laminate sheet, bonded to both sides of 1-1/4-inch particleboard.
 - a. Plastic Laminate for Work Surfaces: High-pressure laminate, 0.050-inch-thick.
 - b. Plastic Laminate for Backing: Backing sheet, 0.028-inch-thick.
 3. Paper Shelves: 3/4-inch-thick, particleboard-core veneer-faced panel with solid-wood banding.
 4. End Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with solid-wood banding at top, bottom, and front edges.
 5. Intermediate Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with solid-wood banding at top, bottom, and front edges.
 6. Back Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with solid-wood banding at top and bottom edges.
 7. Posts: 1-1/2-inch diameter epoxy coated, steel tube, with top cap and adjustable glides.
 8. Vertical Wire Management: Provide wireway between work surface and paper shelf.
 9. Grommets: Provide 12 inch by 1-3/4-inch plastic paper grommet in each section of work surface.
- D. Tables: Consisting of tops, legs, and features as indicated.
1. Tops: Plastic-laminate sheet bonded to both sides of 1-1/4-inch particleboard.
 - a. Plastic Laminate for Tops: High-pressure laminate, 0.050-inch-thick.
 - b. Plastic Laminate for Backing: Backing sheet, 0.028-inch-thick.
 - c. Provide solid-wood edging at perimeter edges of tops.
 - d. Provide aprons at perimeter of tops.

2. Legs: 2-1/2-inch diameter epoxy coated, steel tube, with adjustable glides.
3. Table Types:
 - a. Computer/Reference Tables: Provide with table racks of 1-inch-thick, particleboard-core veneer-faced panel with solid-wood banding and three-compartment call-slip boxes.
 - b. Index Tables: Provide with index racks of 1-inch-thick, particleboard-core veneer-faced panel with solid-wood banding.
 - c. Library Tables: Provide in configurations indicated.
 - 1) For additional table top support for tables 48 inches wide or 90 inches long, or greater.

E. Carrels:

1. Modular Carrels: Consisting of work surface; shelves as indicated; end, intermediate, and back panels.
 - a. Work Surfaces: Plastic-laminate sheet, bonded to 1-1/4-inch particleboard.
 - 1) Plastic Laminate for Work Surfaces: High-pressure laminate, 0.050-inch-thick.
 - 2) Plastic Laminate for Backing: Backing sheet, 0.028-inch-thick.
 - 3) Provide solid-wood edging on front edge of work surface.
 - b. Shelves: 1-inch-thick, particleboard-core veneer-faced panel with solid-wood banding.
 - c. Diametron Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with solid-wood banding around all four edges.
 - d. Diametrix Panels: 3/4-inch-thick, particleboard-core veneer-faced panel with solid-wood banding at top and bottom edges.
 - e. Posts: 1-1/2-inch diameter epoxy coated, steel tube, with top cap and adjustable glides.

F. Carrel Tables: Consisting of tops, legs, and features as indicated.

1. Tops: Plastic-laminate sheet bonded to both sides of 1-1/4-inch particleboard.
 - a. Plastic Laminate for Tops: High-pressure laminate, 0.050-inch-thick.
 - b. Plastic Laminate for Backing: Backing sheet, 0.028-inch-thick.
 - c. Provide solid-wood edging at all four edges of tops.
 - d. Provide apron at all four edges of tops.
2. Legs: 2-1/2-inch diameter epoxy coated, steel tube, with adjustable glides.
3. Racks: 1-inch-thick, particleboard-core veneer-faced panel with solid-wood banding.

G. Display Furniture:

1. Dictionary Stands: Consisting of sloped top; shelves as indicated; back and end panels; on legs.
 - a. Tops: Plastic-laminate sheet, bonded to 1-1/4-inch backing.
 - 1) Plastic Laminate for Tops: High-pressure laminate, 0.050-inch-thick.
 - 2) Plastic Laminate for Backing: Backing sheet, 0.028-inch-thick.
 - 3) Provide retaining strip at front.
 - b. Shelves: 3/4-inch-thick, particleboard-core veneer-faced panel with solid-wood banding.
 - c. End Panels: 1-inch-thick, particleboard-core veneer-faced panel with solid-wood banding on vertical edges.
 - d. Back Panels: 1/4-inch-thick, veneer-core veneer-faced panel.
 - e. Diametron Legs: 2-1/2-inch diameter epoxy coated, steel tube, with adjustable glides; 1-inch by 2-inch tubular steel apron rails.
 - f. Diametrix Legs: 1-1/2-inch diameter epoxy coated, steel tube, with top cap and adjustable glides.
2. Atlas Stands: Consisting of sloped top; pull-out shelves as indicated; back and end panels; on legs.
 - a. Tops: Plastic-laminate sheet, bonded to 1-1/4-inch backing.
 - 1) Plastic Laminate for Tops: High-pressure laminate, 0.050-inch-thick.
 - 2) Provide self-edge for back and retaining strip at front.
 - b. Shelves: 3/4-inch-thick, veneer-core veneer-faced panel with solid-wood banding; with full-extension ball bearing slides with stops.
 - c. End Panels: 1-inch-thick, particleboard-core veneer-faced panel with solid-wood banding on vertical edges.
 - d. Back Panels: 1/4-inch-thick, veneer-core veneer-faced panel.
 - e. Diametron Legs: 2-1/2-inch diameter epoxy coated, steel tube, with adjustable glides; 1-inch by 2-inch tubular steel apron rails.
 - f. Diametrix Legs: 1-1/2-inch diameter epoxy coated, steel tube, with top cap and adjustable glides.

3. Display Tables: Consisting of metal-framed glass case mounted to table with top, legs, and features as indicated.
 - a. Metal Display Case Frames: Extruded aluminum in dark bronze finish; top of case hinged with continuous piano-type hinge and equipped with two point lock and lid supports.
 - b. Glass: 3/16-inch-thick clear tempered glass at sides and top.
 - c. Tops: Plastic-laminate sheet, bonded to both sides of 1-1/4-inch particleboard.
 - 1) Plastic Laminate for Tops: High-pressure laminate, 0.050-inch-thick.
 - 2) Plastic Laminate for Backing: Backing sheet, 0.028-inch-thick.
 - 3) Provide solid-wood edging at all four edges of tops.
 - d. Legs: 2-1/2-inch diameter epoxy coated, steel tube, with adjustable glides; 1-inch by 2-inch tubular steel apron rails.
4. Display Kiosks: Consisting of metal-framed core unit; top and bottom panels; base; specialty panels and features as indicated.
 - a. Core Units: 2-1/2-inch diameter epoxy coated, steel tube posts; 1-inch by 2-inch steel rails.
 - b. Top and Bottom Panels: 1-3/16-inch-thick, particleboard-core veneer-faced panel with solid-wood banding around all four edges.
 - c. Bases: 3/4-inch-thick panels, with adjustable glides.
 - d. Specialty Panels:
 - 1) Slatwall Panel: 1-inch-thick wood veneer slatwall panel, with 1-1/4-inch by 1-3/4-inch solid-wood frame.
 - 2) Tackboard Panel: 1-inch-thick tackboard panel faced with 1/4-inch-thick cork, with 1-1/4-inch by 1-1/4-inch solid-wood frame.
 - 3) Glass Panel: 1/4-inch-thick clear tempered glass panel, with 1-1/4-inch by 1-3/4-inch solid-wood frame.
 - e. Shelves:
 - 1) Glass Shelves: 1/4-inch-thick clear tempered glass.
 - 2) Wood Shelves: 3/4-inch thick, veneer-faced panel.
 - f. Media Carousels:
 - 1) Paperback Book Type: Capacity of approximately 120 books; two towers per face.
 - 2) Compact Disc Type: Capacity of approximately 440 discs; one tower per face.
 - 3) Video Cassette Type: Capacity of approximately 60 VCR tapes; two towers per face.

2.8 SEATING

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the following:
 - 1. Lounge Chairs: Worden Company; Forum.
 - 2. Task Chairs: Worden Company; Reference.
 - 3. Student Chairs: Community, Jasper Seating Company, Inc.; Americana.
- B. Lounge Chairs: Solid-wood framed upholstered chairs, with adjustable glides.
 - 1. Configurations: Framed half panel.
 - 2. Backs: Fabric upholstered; 2-1/4-inch-thick polyurethane foam.
 - 3. Seats: Fabric upholstered; 2-1/4-inch-thick polyurethane foam over spring unit.
 - 4. Side Panels: Fabric upholstered; 3/4-inch-thick polyurethane foam.
 - 5. Fabric: Grade 3
- C. Task Chairs: Low-base swivel, ergonomic, adjustable, upholstered chairs; on five-prong base with casters.
 - 1. Configurations: Armless.
 - 2. Backs: Fabric upholstered; 2-inch-thick polyurethane foam.
 - 3. Seats: Fabric upholstered; 2-1/2-inch-thick polyurethane foam.
 - 4. Fabric: Grade 3
- D. Student Chairs: Solid-wood chairs, with adjustable glides.
 - 1. Configurations: Armless.
 - 2. Backs: 1-inch-thick solid-wood cross backs, with 1-inch by 3/8-inch vertical wood slats.
 - 3. Seats: 1-1/4-inch-thick, constructed of solid-wood members.
 - 4. Arms: 1-1/4-inch-thick solid-wood, with 1-1/2-inch-thick solid-wood arm posts.
 - 5. Front Posts: 2-inch-thick solid-wood, tapered.
 - 6. Rear Posts: 1-1/4-inch-thick solid-wood.
 - 7. Stretchers: 1-inch-thick solid-wood side stretchers and cross-stretcher.

2.9 MATERIALS

- A. Steel: Uncoated, cold-rolled, steel substrate complying with ASTM A 1008/A 1008M, Commercial Steel (CS), exposed.
- B. Aluminum: ASTM B 221, Alloy 6063-T5/T52.
- C. Particleboard: ANSI A208.1, Grade M-3.
- D. Certified Wood: Fabricate wood products from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
- E. Solid Wood: Clear hardwood lumber, selected for compatible grain and color.
 - 1. Wood Species and Cut: Red oak, plain sliced.
 - 2. Staining and Finish: As selected by Architect from manufacturer's full range.

- F. Veneer-Faced Panels: HPVA HP-1, with face veneer of species indicated, with Grade A faces; made with materials containing no urea formaldehyde; that comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
 - 1. Face Veneer Species and Cut: Red oak, plain sliced.
 - 2. Staining and Finish: As selected by Architect from manufacturer's full range.
- G. High-Pressure Decorative Laminate: NEMA LD 3, Grade HGL.
 - 1. Colors, Textures, and Patterns: As selected by Architect from manufacturer's full range.
- H. Thermoset Decorative Overlay: Thermally fused, melamine-impregnated decorative paper.
 - 1. Colors: As selected by Architect from manufacturer's full range.
- I. Edgebanding: Minimum 1/8-inch-thick solid wood of same species as face veneer.
 - 1. Colors: As selected by Architect from manufacturer's full range.
- J. Adhesives: Adhesives shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- K. Tempered Float Glass: ASTM C 1048, Kind FT, Condition A, Type I, Class 1 (clear), Quality-Q3, with exposed edges seamed before tempering.
- L. Fabric: Manufacturer's standard with flame-retardant treatment.
 - 1. Color and Pattern: As selected by Architect from manufacturer's full range.
- M. Upholstery Padding: Flexible, fire-retardant, polyurethane foam.

2.10 STRUCTURAL SUPPORT

- A. Wall Anchorage: Manufacturer's standard, galvanized steel anchor designed to secure shelving to adjacent wall. Provide one per shelving unit for each shelving unit adjacent to a wall.

2.11 GENERAL FINISH REQUIREMENTS

- A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.12 STEEL FINISHES

- A. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to achieve a minimum dry film thickness of 2 mils.
 - 1. Color and Gloss: As selected by Architect from manufacturer's full range.

2.13 ALUMINUM FINISHES

- A. Color Anodic Finish: AAMA 611, AA-M12C22A32/A34, Class II, 0.010 mm or thicker.
- B. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

2.14 WOOD FINISHES

- A. Preparation: Sand wood units after assembling for uniform smoothness at least equivalent to that produced by 220-grit sanding and without machine marks, cross sanding, or other surface blemishes.
- B. Staining: Remove fibers and dust and apply wash-coat sealer and stain to exposed and semiexposed surfaces as required to provide uniform color and to match approved samples.
- C. Finishing: Apply manufacturer's standard, baked, clear finish consisting of a sealer and a conversion varnish or nitrocellulose lacquer topcoat. Sand and wipe clean between applications of sealer and topcoat.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances, location of framing and reinforcements, and other conditions affecting performance of library stack systems.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

- A. Vacuum finished floor over which shelving is to be installed.

- B. Before installing veneer-faced panels, condition materials to average prevailing humidity in installation areas for a minimum of 48 hours unless longer conditioning is recommended by manufacturer.

3.3 INSTALLATION, WOOD CASE LIBRARY SHELVING

- A. Install library shelving systems at locations indicated on Drawings and according to manufacturer's written instructions.
- B. Level units with integral adjustable leveling devices to a tolerance of 1/8 inch in 96 inches for level and plumb.
- C. Install using anchorage or bracing as recommended by manufacturer and as required for stability.
- D. Install the following with concealed fasteners:
 - 1. End panels.
 - 2. Canopy tops.
 - 3. Countertops.
- E. Install shelves at equal spacing in each unit.

3.4 INSTALLATION, CIRCULATION DESK ASSEMBLY

- A. Install level, plumb, and true; shim as required, using concealed shims. Where circulation desk assembly abuts other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical.
- B. Base Cabinets: Set cabinets straight, level, and plumb. Adjust subtops within 1/16 inch of a single plane. Bolt adjacent cabinets together with joints flush, tight, and uniform. Align similar adjoining doors and drawers to a tolerance of 1/16 inch.
- C. Install hardware uniformly and precisely. Set hinges snug and flat in mortises unless otherwise indicated. Adjust and align hardware so moving parts operate freely and contact points meet accurately. Allow for final adjustment after installation.
- D. Adjust casework and hardware so doors and drawers operate smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer.

3.5 INSTALLATION, LIBRARY FURNITURE AND SEATING

- A. Install level, plumb, and true. Properly align and adjust so that units perform correctly.

3.6 CLEANING AND PROTECTING

- A. Repair or remove and replace defective work as directed on completion of installation.

- B. Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.
- C. Protect installed products from damage during remainder of the construction period.

END OF SECTION 12 56 51

SECTION 14 42 00 - WHEELCHAIR LIFTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Vertical platform lifts.

1.3 DEFINITIONS

- A. Definitions in ASME A18.1 apply to Work of this Section.

1.4 SUBMITTALS, GENERAL

- A. General: Submit all action submittals and informational submittals required by this Section concurrently.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components, and finishes for lifts. Include rated capacities, operating characteristics, electrical characteristics, safety features, controls, finishes, and accessories.
 - 1. Vertical platform lift.
- B. Shop Drawings: For each lift.
 - 1. Include plans, elevations, sections, details, attachments to other work, and required clearances.
 - 2. Indicate dimensions, weights, loads, and points of load to building structure.
 - 3. Include details of equipment assemblies, method of field assembly, components, and location and size of each field connection.
 - 4. Include diagrams for power, signal, and control wiring.
- C. Samples: For surfaces and components with factory-applied color finishes.
 - 1. Include Samples of integrally colored materials and accessories involving color selection.
- D. Sample Warranty: For special warranty.

1.6 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each lift.

1. Include statement that runway, ramp or pit, dimensions as shown on Drawings, and electrical service as shown and specified are adequate for lift being provided.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lift to include in operation and maintenance manuals.

1. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - a. Parts list with sources indicated.
 - b. Recommended parts inventory list.

B. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted use of lifts.

C. Warranty: Executed special warranty.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of lifts that fail in materials or workmanship within specified warranty period, at no cost to Owner.

1. Warranty Period: Not less than 4 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Accessibility Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines, ICC A117.1, and building code in effect for Project.

B. Regulatory Requirements: Comply with ASME A18.1, "Safety Standard for Platform Lifts and Stairway Chairlifts."

2.2 VERTICAL PLATFORM LIFT

- A. Vertical Platform Lift, General: Preengineered lift system.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Symmetry Elevating Solutions; Unenclosed Vertical Wheelchair Lift Model UL or comparable product by the following:
 - a. Garaventa Accessibility.
 - b. Inclinor Company of America.
- B. Platform Size: 36 by 48 inches.
- C. Door Operation and Clear Opening Width: Low-energy, power-operated doors that remain open for 20 seconds minimum; end door with minimum 32-inch clear opening width.
- D. Rated Speed: Between 9 to 12 fpm.
- E. Power Supply: 115 V, 30 Amp, single phase.
- F. Emergency Operation: Provide manual operation and battery power system to raise or lower unit in case of malfunction or power loss.
- G. Self-Supporting Unit: Support vertical loads of unit only at base, with lateral support only at landing levels.
- H. Partial Runway Enclosure: Manufacturer's standard enclosure assembly.
 - 1. Runway Enclosure: Rectangular steel-tube frame with flush steel-sheet panels.
- I. Platform: Steel sheet or galvanized-steel sheet with manufacturer's standard black rubber flooring.
- J. Platform Enclosure and Door: Rectangular steel-tube frame with flush steel-sheet panels.
- K. Ramp: Fixed ramp matching platform to provide transition from floor to lift platform at bottom landing.

2.3 MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Steel Tubing: ASTM A 500/A 500M.
- C. Steel Pipe: ASTM A 53/A 53M; standard weight (Schedule 40) unless otherwise indicated or required by loads.
- D. Steel Sheet: ASTM A 1008/A 1008M, cold-rolled commercial steel (CS) or ASTM A 1011/A 1011M hot-rolled, commercial steel (CS); as required for each use.
- E. Galvanized-Steel Sheet: ASTM A 653/A 653M, G90 zinc coating,

- F. Galvanizing: Hot-dip galvanize items complying with the following:
 - 1. ASTM A 123/A 123M, for galvanizing steel and iron products.
 - 2. ASTM A 153/A 153M, for galvanizing steel and iron hardware.
- G. Aluminum: Alloy and temper recommended by aluminum producer and finisher for type of use, corrosion resistance, and finish indicated; manufacturer's standard strengths and thicknesses for type of use.
 - 1. Extruded Aluminum: ASTM B 221.
 - 2. Aluminum Sheet and Plate: ASTM B 209.
- H. Inserts: Furnish required concrete and masonry inserts and similar anchorage devices for installing structural members, guide rails, machines, and other lift components where installation of devices is specified in another Section.
- I. Expansion Anchors: Anchor-bolt-and-sleeve assembly of material indicated below with capability to sustain a load equal to 10 times the load imposed as determined by testing according to ASTM E 488 conducted by a qualified independent testing agency.
 - 1. Material: Group 1, Alloy 304 or Alloy 316, stainless-steel bolts and nuts complying with ASTM F 593 and ASTM F 594.
- J. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M.

2.4 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.5 FINISHES

- A. Steel and Galvanized-Steel Factory Finish:
 - 1. Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of 2 mils.
 - 2. Color and Gloss: As selected by Architect from manufacturer's full range.

B. Aluminum Finishes:

1. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
 - a. Color: As selected by Architect from full range of industry colors and color densities.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, critical dimensions, and other conditions affecting performance of the Work.
- B. Minimum Headroom Clearance: Verify that installed lift will have a minimum headroom of 80 inches above any point on platform floor at any point of travel.
- C. Minimum Headroom Clearance: Verify that installed lift will have a minimum headroom of 79 inches at any point during travel.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.
- E. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 INSTALLATION

- A. General: Comply with ASME A18.1 and manufacturer's written instructions for installation of lifts unless otherwise indicated.
- B. Wiring Method: Conceal conductors and cables within housings of units or building construction. Do not install conduit exposed to view in finished spaces. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
- C. Coordinate runway doors with platform travel and positioning, for accurate alignment and minimum clearance between platforms, runway doors, sills, and door frames.
- D. Position sills accurately and fill space under sills solidly with nonshrink, nonmetallic grout.
- E. Coordinate platform doors with platform travel and positioning.
- F. Adjust stops for accurate stopping and leveling at each landing, within required tolerances.
 1. Leveling Tolerance: 1/4 inch up or down, regardless of load and direction of travel.

- G. Lubricate operating parts of lift, including drive mechanism, guide rails, hinges, safety devices, and hardware.
- H. Test safety devices and verify smoothness of required protective enclosures and other surfaces.

3.3 FIELD QUALITY CONTROL

- A. Acceptance Testing: On completion of lift installation and before permitting use of lifts, perform acceptance tests as required and recommended by ASME A18.1 and authorities having jurisdiction.
- B. Operating Test: In addition to acceptance testing, load lifts to rated capacity and operate continuously for 30 minutes between lowest and highest landings served. Readjust stops, signal equipment, and other devices for accurate stopping and operation of system.
- C. Advise Owner, Architect, and authorities having jurisdiction in advance of dates and times tests are to be performed on lifts.

3.4 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of lift Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper lift operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lifts. Include a review of emergency systems and emergency procedures to be followed at time of operational failure and other building emergencies.
- B. Check operation of lifts with Owner's personnel present and before date of Substantial Completion. Determine that operating systems and devices are functioning properly.
- C. Check operation of lifts with Owner's personnel present not more than one month before end of warranty period. Determine that operating systems and devices are functioning properly.

END OF SECTION 14 42 00

SECTION 21 05 00 - COMMON WORK RESULTS FOR FIRE SUPPRESSION**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. The Work of this Section includes:

- 1. Motors.
- 2. Sleeves without waterstop.
- 3. Sleeves with waterstop.
- 4. Stack-sleeve fittings.
- 5. Sleeve-seal systems.
- 6. Grout.
- 7. Silicone sealants.
- 8. Escutcheons.

1.3 ACTION SUBMITTALS

- A. Product Data:

- 1. For each type of product, excluding motors which are included in Part 1 of the fire-suppression equipment Sections.
 - a. Include construction details, material descriptions, and dimensions of components.
 - b. Include operating characteristics and furnished accessories.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

PART 2 - PRODUCTS**2.1 SLEEVES AND SLEEVE SEALS**

- A. Sleeves without Waterstop:

- 1. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron, with plain ends.
- 2. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, hot-dip galvanized, with plain ends.

3. Steel Sheet Sleeves: ASTM A653/A653M, 24-gauge minimum thickness; hot-dip galvanized, round tube closed with welded longitudinal joint.

B. Sleeves with Waterstop:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Advance Products & Systems, LLC.
 - b. CALPICO, Inc.
 - c. GPT; an EnPro Industries company.
 - d. Metraflex Company (The).
2. Description: Manufactured galvanized steel, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall.

C. Sleeve-Seal Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Advance Products & Systems, LLC.
 - b. CALPICO, Inc.
 - c. GPT; an EnPro Industries company.
 - d. Metraflex Company (The).
 - e. Proco Products, Inc.
2. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - a. Hydrostatic Seal: 20 psig minimum.
 - b. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
 - c. Pressure Plates: Stainless steel, Type 316.
 - d. Connecting Bolts and Nuts: Stainless steel, Type 316, of length required to secure pressure plates to sealing elements.

D. Grout:

1. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
2. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
3. Design Mix: 5000 psi, 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

E. Silicone Sealants:

1. Comply with requirements for sealants in non-fire rated penetrations specified in Section 07 92 00 "Joint Sealants."

2. Silicone Sealant, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant.
3. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. GE Construction Sealants; Momenitive Performance Materials Inc.
 - b. Sherwin-Williams Company (The).
 - c. Sika Corporation.
 - d. The Dow Chemical Company.
4. Standard: ASTM C920, Type S, Grade NS, Class 25, Use NT.

2.2 ESCUTCHEONS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. BrassCraft Manufacturing Co.; a Masco company.
 2. Dearborn Brass.
 3. Jones Stephens Corp.
 4. Keeney Manufacturing Company (The).
 5. ProFlo; a Ferguson Enterprises, Inc. brand.
- B. Escutcheon Types:
 1. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
 2. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished, chrome-plated finish and spring-clip fasteners.
 3. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.
 4. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed hinge; and spring-clip fasteners.
- C. Floor Plates:
 1. Split Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 INSTALLATION OF PIPE SWING CONNECTIONS

- A. Install pipe offsets in accordance with NFPA 13 requirements for expansion and contraction compensation.

3.3 INSTALLATION OF SLEEVES, GENERAL

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
 - 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
 - 2. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
 - 3. Using grout or silicone sealant, seal space outside of sleeves in floors/slabs/walls without sleeve-seal system. Select to maintain fire-resistance of floor/slab/wall.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants that joint sealant manufacturer's literature indicates is appropriate for size, depth, and location of joint.
- E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.4 INSTALLATION OF SLEEVES WITH WATERSTOP

- A. Install sleeve with waterstop as new walls and slabs are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange centered across width centered in concrete slab or wall.

- C. Secure nailing flanges to wooden concrete forms.
- D. Using grout or silicone sealant, seal space around outside of sleeves.

3.5 INSTALLATION OF SLEEVE-SEAL SYSTEMS

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building and passing through exterior walls.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Assemble sleeve-seal system components and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.6 INSTALLATION OF ESCUTCHEONS

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

3.7 FIELD QUALITY CONTROL

- A. Sleeves and Sleeve Seals:
 - 1. Perform the following tests and inspections:
 - a. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
 - b. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.
 - 2. Prepare test and inspection reports.
- B. Escutcheons:
 - 1. Using new materials, replace broken and damaged escutcheons and floor plates.

3.8 SLEEVES APPLICATION

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete Walls above and below Grade:
 - a. Sleeves with waterstops.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

2. Concrete Slabs-on-Grade:
 - a. Sleeves with waterstops.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
3. Concrete Slabs above Grade:
 - a. Sleeves with waterstops.
4. Interior Walls and Partitions:
 - a. Sleeves without waterstops.

3.9 ESCUTCHEONS APPLICATION

- A. Escutcheons for New Piping:
 1. Bare Piping at Wall and Floor Penetrations in Finished Spaces:
 - a. One piece, cast brass with polished, chrome-plated finish.
 2. Bare Piping at Ceiling Penetrations in Finished Spaces:
 - a. One piece, cast brass with polished, chrome-plated finish.
 3. Bare Piping in Unfinished Service Spaces:
 - a. One piece, cast brass with polished, chrome-plated finish.
 4. Bare Piping in Equipment Rooms:
 - a. One piece, cast brass with polished, chrome-plated finish.
- B. Install floor plates for piping penetrations of equipment room floors.
- C. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 1. New Piping and Relocated Existing Piping: One piece, floor plate.

END OF SECTION 21 05 00

SECTION 21 05 17 - SLEEVES AND SLEEVE SEALS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves without waterstop.
2. Sleeves with waterstop.
3. Stack-sleeve fittings.
4. Sleeve-seal systems.
5. Grout.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for sleeves seals.

1. Sleeve-seal systems.
2. Firestopping.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SLEEVES WITHOUT WATERSTOP

- A. Cast-Iron Pipe Sleeves:** Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends.
- B. Steel Pipe Sleeves:** ASTM A53/A53M, Type E, Grade B, Schedule 40, hot-dip galvanized, with plain ends.
- C. Steel Sheet Sleeves:** ASTM A653/A653M, 0.0239-inch minimum thickness; hot-dip galvanized, round tube closed with welded longitudinal joint.

2.2 SLEEVES WITH WATERSTOP

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Advance Products & Systems, LLC.
2. CALPICO, Inc.

3. GPT; an EnPro Industries company.
 4. Metraflex Company (The).
- B. Description: Manufactured galvanized steel, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall.

2.3 STACK-SLEEVE FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Jay R. Smith Mfg Co; a division of Morris Group International.
 2. Wade; a subsidiary of McWane Inc.
 3. Zurn Industries, LLC.
- B. Description: Manufactured, Dura-coated or Duco-coated galvanized cast-iron sleeve with integral clamping flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.

2.4 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Advance Products & Systems, LLC.
 2. CALPICO, Inc.
 3. GPT; an EnPro Industries company.
 4. Metraflex Company (The).
 5. Proco Products, Inc.
- B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
1. Designed to form a hydrostatic seal of 20 psig minimum.
 2. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 3. Pressure Plates: Stainless steel, Type 316.
 4. Connecting Bolts and Nuts: Stainless steel, Type 316 of length required to secure pressure plates to sealing elements.

2.5 PENETRATION FIRESTOPPING

- A. Comply with requirements for sealants in fire rated penetrations specified in Section 07 84 13 "Penetration Firestopping" and Section 22 05 00 "Common Work Results for Plumbing."

2.6 GROUT

- A. Refer to grout product requirements specified in Section 22 05 00 "Common Work Results for Plumbing."

2.7 SILICONE SEALANTS

- A. Comply with requirements for silicone sealants specified in Section 07 92 00 "Joint Sealants" and Section 22 05 00 "Common Work Results for Plumbing."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 INSTALLATION OF SLEEVES - GENERAL

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
 - 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
 - 2. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
 - 3. Using grout or silicone sealant, seal space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.

- E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 07 84 13 "Penetration Firestopping."

3.3 INSTALLATION OF SLEEVES WITH WATERSTOP

- A. Install sleeve with waterstop as new walls and slabs are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal space around outside of sleeves.

3.4 INSTALLATION OF STACK-SLEEVE FITTINGS

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
 - 1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 07 62 00 "Sheet Metal Flashing and Trim."
 - 3. Install section of cast-iron soil pipe to extend sleeve to 3 inches above finished floor level.
 - 4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 5. Using waterproof silicone sealant, seal space between top hub of stack-sleeve fitting and pipe.
- B. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of floors at pipe penetrations. Seal pipe penetrations with fire- or smoke-stop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.5 INSTALLATION OF SLEEVE-SEAL SYSTEMS

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building and passing through exterior walls.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.6 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
2. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

B. Prepare test and inspection reports.

3.7 SLEEVE SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above and below Grade:
 - a. Sleeves with waterstops.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
2. Concrete Slabs-on-Grade:
 - a. Sleeves with waterstops.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
3. Concrete Slabs above Grade:
 - a. Sleeves with waterstops or stack-sleeve fittings.
4. Interior Walls and Partitions:
 - a. Sleeves without waterstops.

END OF SECTION 21 05 17

SECTION 21 05 18 - ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Escutcheons.
 - 2. Floor plates.

1.3 DEFINITIONS

- A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. BrassCraft Manufacturing Co.; a Masco company.
 - 2. Dearborn Brass.
 - 3. Keeney Manufacturing Company (The).
 - 4. ProFlo; a Ferguson Enterprises, Inc. brand.

2.2 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished, chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.
- D. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed hinge; and spring-clip fasteners.

2.3 FLOOR PLATES

- A. Split Floor Plates: Steel with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern type with polished, chrome-plated finish and spring clip fastener.
 - 2. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
 - 3. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
 - 4. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - 5. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - 6. Bare or Insulated Piping in Unfinished Service Spaces and Equipment Rooms: No escutcheons required.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. New Piping: One-piece, floor plate.
 - 2. Existing Piping: Split floor plate.

3.2 FIELD QUALITY CONTROL

- A. Using new materials, replace broken and damaged escutcheons and floor plates.

END OF SECTION 21 05 18

SECTION 21 05 48 - VIBRATION AND SEISMIC CONTROLS FOR FIRE PROTECTION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Elastomeric isolation pads.
 - 2. Elastomeric isolation mounts.
 - 3. Restrained elastomeric isolation mounts.
 - 4. Open-spring isolators.
 - 5. Housed-spring isolators.
 - 6. Restrained-spring isolators.
 - 7. Housed-restrained-spring isolators.
 - 8. Pipe-riser resilient supports.
 - 9. Resilient pipe guides.
 - 10. Elastomeric hangers.
 - 11. Spring hangers.
 - 12. Snubbers.
 - 13. Restraint channel bracings.
 - 14. Restraint cables.
 - 15. Seismic-restraint accessories.
 - 16. Mechanical anchor bolts.
 - 17. Adhesive anchor bolts.

1.3 DEFINITIONS

- A. IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.
- C. OSHPD: Office of Statewide Health Planning & Development (for the State of California).

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.

2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic-restraint component required.
 - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ES.
 - b. Annotate to indicate application of each product submitted and compliance with requirements.
 3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.
- B. Shop Drawings:
1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment.
- C. Delegated-Design Submittal: For each vibration isolation and seismic-restraint device.
1. Include design calculations and details for selecting vibration isolators and seismic restraints complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 2. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, due to seismic forces required to select vibration isolators, and due to seismic restraints.
 3. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system was examined for excessive stress and that none exists.
 4. Seismic-Restraint Details:
 - a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
 - c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
 - d. Preapproval and Evaluation Documentation: By an evaluation service member of ICC-ES, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of vibration isolation device installation and seismic bracing for plumbing piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.
- B. Qualification Data: For professional engineer.
- C. Welding certificates.
- D. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.
- B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are unavailable, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic-Restraint Loading:
 - 1. Site Class as Defined in the IBC: D.
 - 2. Assigned Seismic Use Group or Building Category as Defined in the IBC: III.
 - a. Component Importance Factor: 1.25.
 - b. Component Response Modification Factor: Refer to structural drawings.
 - c. Component Amplification Factor: Refer to structural drawings.
 - 3. Design Spectral Response Acceleration at Short Periods 0.216%g.
 - 4. Design Spectral Response Acceleration at 1.0-Second Period: 0.088%g.

5. Rated strengths, features, and applications shall be as defined in reports by an evaluation service member of ICC-ES.
 - a. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they are subjected.

2.2 OPEN-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators:

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psig.
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

2.3 PIPE-RISER RESILIENT SUPPORT

A. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2-inch- thick neoprene .

1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
2. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.

2.4 RESILIENT PIPE GUIDES

A. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2-inch- thick neoprene.

1. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.5 ELASTOMERIC HANGERS

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:

1. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.

2. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.6 SPRING HANGERS

- A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:
 1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
 7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
 8. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

2.7 SNUBBERS

- A. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
 1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
 2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
 3. Maximum 1/4-inch air gap, and minimum 1/4-inch thick resilient cushion.

2.8 RESTRAINT CHANNEL BRACINGS

- A. Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.9 RESTRAINT CABLES

- A. Restraint Cables: ASTM A 603 galvanized-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

2.10 SEISMIC-RESTRAINT ACCESSORIES

- A. Hanger-Rod Stiffener: Reinforcing steel angle clamped to hanger rod.
- B. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.
- C. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- D. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
- E. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.11 MECHANICAL ANCHOR BOLTS

- A. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.12 ADHESIVE ANCHOR BOLTS

- A. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES.
- B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete"
- B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.
- C. Equipment Restraints:
 - 1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
 - 2. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES that provides required submittals for component.
- D. Piping Restraints:
 - 1. Comply with requirements in MSS SP-127.
 - 2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
 - 3. Brace a change of direction longer than 12 feet
- E. Install cables so they do not bend across edges of adjacent equipment or building structure.
- F. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES that provides required submittals for component.
- G. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- H. Drilled-in Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.

2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
 5. Test to 90 percent of rated proof load of device.
 6. Measure isolator restraint clearance.

- 7. Measure isolator deflection.
- 8. Verify snubber minimum clearances.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Adjust isolators after piping system is at operating weight.
- B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

END OF SECTION 22 05 48

SECTION 21 05 53 - IDENTIFICATION FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Equipment and piping labels.

1.3 ACTION SUBMITTALS

- A. Product Data: For the following products:
 - 1. Equipment labels.
 - 2. Warning signs and labels
 - 3. Pipe labels.
 - 4. Valve tags.

1.4 CLOSEOUT SUBMITTALS

- A. Equipment-Label Schedule: Include a listing of all equipment to be labeled and the proposed content for each label.
- B. Valve Schedules: Valve numbering scheme.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, with predrilled holes for attachment hardware.
 - 2. Letter Color: White.
 - 3. Background Color: Black.
 - 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 7. Fasteners: Stainless-steel rivets or self-tapping screws.
 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.
 - C. Equipment-Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, with predrilled holes for attachment hardware.
- B. Letter Color: White.
- C. Background Color: Red.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Not accepted.
- D. Pipe-Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; pipe size; and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches high.
- E. Pipe-Label Colors:
 - 1. Background Color: Red.
 - 2. Letter Color: White.

2.4 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping-system abbreviation and 1/2-inch numbers.
 - 1. Tag Material: Brass, 0.032 inch thick, with predrilled holes for attachment hardware.
 - 2. Fasteners: Brass beaded chain or S-hook.
 - 3. Valve-Tag Color: Red.
 - 4. Letter Color: White.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - 1. Valve-tag schedule shall be included in operation and maintenance data.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 LABEL INSTALLATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install or permanently fasten labels on each major item of mechanical equipment.
- D. Locate equipment labels where accessible and visible.
- E. Piping Color-Coding: Painting of piping is specified in Section 099123 "Interior Painting."
- F. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection excluding short takeoffs. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

3.3 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems. List tagged valves in a valve-tag schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below:
 - 1. Valve-Tag Size and Shape:
 - a. Wet-Pipe Sprinkler System: 1-1/2 inches, round.

3.4 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 21 05 53

SECTION 21 13 13 - WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipes, fittings, and specialties.
 - 2. Backflow preventers.
 - 3. Fire-protection valves.
 - 4. Fire-department connections.
 - 5. Sprinklers.
 - 6. Alarm devices.
 - 7. Manual control stations.
 - 8. Control panels.
 - 9. Pressure gages.

1.3 DEFINITIONS

- A. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175 psig maximum.

1.4 SYSTEM DESCRIPTIONS

- A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply through alarm valve. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.

1.5 PERFORMANCE REQUIREMENTS

- A. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.
- B. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
 - 1. Flow test information: Obtain flow test information from local water authority for use in final design. Pay all costs associated with conducting flow test.

- C. Sprinkler system design shall be approved by authorities having jurisdiction.
1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
 2. Sprinkler Occupancy Hazard Classifications:
 - a. Light Hazard Occupancy:
 - 1) All the existing building, unless noted otherwise.
 - b. Ordinary Hazard, Group 1 Occupancy:
 - 1) Storage Rooms indicated on plans.
 3. Minimum Density for Automatic-Sprinkler Piping Design:
 - a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
 - b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
 4. Maximum Protection Area per Sprinkler:
 - a. Office Spaces: 120 sq. ft.
 - b. Storage Areas: 130 sq. ft.
 - c. Mechanical Equipment Rooms: 130 sq. ft.
 - d. Electrical Equipment Rooms: 130 sq. ft.
 - e. Other Areas: According to NFPA 13 recommendations unless otherwise indicated.
 5. Total Combined Hose-Stream Demand Requirement: According to NFPA 13 unless otherwise indicated:
 - a. Light-Hazard Occupancies: 100 gpm for 30 minutes.
 - b. Ordinary-Hazard Occupancies: 250 gpm for 60 to 90 minutes.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For wet-pipe sprinkler systems. Include plans, elevations, sections, details, and attachments to other work.
1. Wiring Diagrams: For power, signal, and control wiring.
 2. Sprinkler Head and Piping Layout:
 - a. Include field survey work required for obtaining dimensions and layout of existing obstructions and conditions affecting design and installation of fire protection systems.

- b. Coordinate location of sprinkler heads and piping to eliminate interference with other work.
 - c. Sprinkler head layout drawings intended to represent general geometric appearance required for acceptable sprinkler installation within finished ceiling spaces. Do not interpret as representing maximum number of sprinklers required for compliance with NFPA 13 standards for building spaces to be sprinklered. Provide additional fire sprinklers coverage required for compliance with NFPA 13 standards and local fire department codes and ordinances using specified sprinkler heads.
- 3. Design sprinkler piping layout and piping supports in finished spaces to be hidden from view above ceilings, behind walls or inside chases. Coordinate with the Architect by highlighting areas on shop drawings where piping or supports cannot be concealed from view in finished spaces. Do not install exposed piping or piping supports in finished spaces without written approval of Architect. Piping and/or supports installed exposed to view without prior approval from Architect will be relocated at the Contractor's expense.
- 4. Design sprinkler piping layout and sprinkler head layout in unfinished spaces including: coordinate spacing and locations with obstructions to ensure compliance with NFPA 13 standards for obstructions caused by lighting rigging equipment, lights, structural members, roof vents openings and ductwork, etc.
- C. Delegated-Design Submittal: For wet-pipe sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.7 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Building structural components.
 - 2. Domestic water piping.
 - 3. Compressed air piping.
 - 4. HVAC hydronic piping, ductwork and ceiling hung equipment.
 - 5. Ceiling hung art work or displays.
 - 6. Items penetrating finished ceiling include the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - 7. Details and sections to clarify design and installation to be in conformance with design criteria and standards described in this section.
 - 8. Written statement that coordination has been accomplished with work of other Prime Contractors.

- B. Qualification Data: For qualified Installer and professional engineer.
- C. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations.
- D. Welding certificates.
- E. Fire-hydrant flow test report.
- F. Field Test Reports:
 - 1. Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
- G. Field quality-control reports.

1.8 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For sprinkler specialties to include in emergency, operation, and maintenance manuals.

1.9 QUALITY ASSURANCE

- A. Applicable Standards: Sprinkler system equipment, specialties, accessories, design, installation, and testing shall comply with the following:
 - 1. Fire Code of New York State.
 - 2. NFPA 13 Standard for the Installation of Sprinkler Systems - 2013 edition.
 - 3. NFPA 24 Installation of Private Fire Service Mains and Their Appurtenances - 1995 edition.
 - 4. Materials and devices essential for successful system operation shall be UL listed and FM approved.
- B. Installer Qualifications:
 - 1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
 - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.
- C. Welding Qualifications: Qualify procedures and operators according to 2010 ASME Boiler and Pressure Vessel Code.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.10 COORDINATION

- A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

1.11 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

2.2 STEEL PIPE AND FITTINGS

- A. Standard Weight, Black-Steel Pipe: ASTM A 53/A 53M, Schedule 40, Type F or Type S, Grade A. Pipe ends may be factory or field formed to match joining method.
- B. Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.
- C. Steel Couplings: ASTM A 865, threaded.
- D. Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- E. Malleable- or Ductile-Iron Unions: UL 860.
- F. Cast-Iron Flanges: ASME 16.1, Class 125.
- G. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
- H. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.
- I. Grooved-Joint, Steel-Pipe Appurtenances:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International, Inc.

- b. Corcoran Piping System Co.
 - c. National Fittings, Inc.
 - d. Shurjoint Piping Products.
 - e. Tyco Fire & Building Products LP.
 - f. Victaulic Company.
- 2. Pressure Rating: 175 psig minimum.
 - 3. Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
 - 4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.3 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free.
 - 1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
 - 2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 BACKFLOW PREVENTERS

- A. Double-Check, Detector-Assembly Backflow Preventers:
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide WATTS; Model 709DCDA-OSY or comparable product by one of the following:
 - a. Ames Fire & Waterworks; A WATTS Brand.
 - b. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - c. FEBCO; A WATTS Brand.
 - d. Zurn Industries, LLC.
 - 2. Standard: ASSE 1048 and is FM Global approved or UL listed.
 - 3. Operation: Continuous-pressure applications.
 - 4. Body: Fused Epoxy Coated Cast Iron.
 - 5. End Connections: AWWA 150# Class Flanges.

6. Configuration: Designed for horizontal, straight-through flow.
7. Accessories:
 - a. Valves: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
 - b. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.
8. Capacities and Characteristics: As identified by Contractor Delegated Design for fire suppression system.

2.5 SPECIALTY VALVES

- A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
- B. Pressure Rating:
 1. Standard-Pressure Piping Specialty Valves: 175-psig minimum.
- C. Body Material: Cast or ductile iron.
- D. Size: Same as connected piping.
- E. End Connections: Flanged or grooved.
- F. Alarm Valves:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AFAC Inc.
 - b. Globe Fire Sprinkler Corporation.
 - c. Reliable Automatic Sprinkler Co., Inc.
 - d. Tyco Fire & Building Products LP.
 - e. Venus Fire Protection Ltd.
 - f. Victaulic Company.
 - g. Viking Corporation.
 2. Standard: UL 193.
 3. Design: For horizontal or vertical installation.
 4. Drip Cup Assembly: Pipe drain with check valve to main drain piping.
 5. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Automatic (Ball Drip) Drain Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AFAC Inc.
 - b. Reliable Automatic Sprinkler Co., Inc.
 - c. Tyco Fire & Building Products LP.
2. Standard: UL 1726.
3. Pressure Rating: 175-psig minimum.
4. Type: Automatic draining, ball check.
5. Size: NPS 3/4.
6. End Connections: Threaded.

2.6 SPRINKLER PIPING SPECIALTIES

A. Branch Outlet Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International, Inc.
 - b. National Fittings, Inc.
 - c. Shurjoint Piping Products.
 - d. Tyco Fire & Building Products LP.
 - e. Victaulic Company.
2. Standard: UL 213.
3. Pressure Rating: 175-psig minimum.
4. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
5. Type: Mechanical-tee and -cross fittings.
6. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
7. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
8. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Flow Detection and Test Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AGF Manufacturing Inc.
 - b. Reliable Automatic Sprinkler Co., Inc.
 - c. Tyco Fire & Building Products LP.
 - d. Victaulic Company.
2. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
3. Pressure Rating: 175-psig minimum.
4. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded or grooved.

C. Branch Line Testers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Elkhart Brass Mfg. Company, Inc.
 - b. Fire-End & Croker Corporation.
 - c. Potter Roemer.
2. Standard: UL 199.
3. Pressure Rating: 175 psig.
4. Body Material: Brass.
5. Size: Same as connected piping.
6. Inlet: Threaded.
7. Drain Outlet: Threaded and capped.
8. Branch Outlet: Threaded, for sprinkler.

D. Sprinkler Inspector's Test Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AGF Manufacturing Inc.
 - b. Triple R Specialty.
 - c. Tyco Fire & Building Products LP.

- d. Victaulic Company.
 - e. Viking Corporation.
 - 2. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
 - 3. Pressure Rating: 175-psig minimum.
 - 4. Body Material: Cast- or ductile-iron housing with sight glass.
 - 5. Size: Same as connected piping.
 - 6. Inlet and Outlet: Threaded.
- E. Adjustable Drop Nipples:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CECA, LLC.
 - b. Corcoran Piping System Co.
 - c. Merit Manufacturing; a division of Anvil International, Inc.
 - 2. Standard: UL 1474.
 - 3. Pressure Rating: 250-psig minimum.
 - 4. Body Material: Steel pipe with EPDM-rubber O-ring seals.
 - 5. Size: Same as connected piping.
 - 6. Length: Adjustable.
 - 7. Inlet and Outlet: Threaded.
- F. Flexible Sprinkler Hose Fittings:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Fivalco Inc.
 - b. FlexHead Industries, Inc.
 - c. Gateway Tubing, Inc.
 - 2. Standard: UL 1474.
 - 3. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
 - 4. Pressure Rating: 175-psig minimum.
 - 5. Size: Same as connected piping, for sprinkler.

2.7 SPRINKLERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AFAC Inc.
 - 2. Globe Fire Sprinkler Corporation.
 - 3. Reliable Automatic Sprinkler Co., Inc.
 - 4. Tyco Fire & Building Products LP.
 - 5. Venus Fire Protection Ltd.
 - 6. Victaulic Company.
 - 7. Viking Corporation.
- B. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
- C. Pressure Rating for Automatic Sprinklers: 175-psig minimum.
- D. Automatic Sprinklers with Heat-Responsive Element:
 - 1. Early-Suppression, Fast-Response Applications: UL 1767.
 - 2. Nonresidential Applications: UL 199.
 - 3. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.
- E. Sprinkler Finishes: Chrome plated.
- F. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
 - 1. Ceiling Mounting: Chrome-plated steel, one piece, flat.
 - 2. Sidewall Mounting: Chrome-plated steel, one piece, flat.

2.8 ALARM DEVICES

- A. Alarm-device types shall match piping and equipment connections.
- B. Electrically Operated Alarm Bell:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Fire-Lite Alarms, Inc.; a Honeywell company.
 - b. Notifier; a Honeywell company.
 - c. Potter Electric Signal Company.
 - 2. Standard: UL 464.

3. Type: Vibrating, metal alarm bell.
4. Size: 6-inch minimum- diameter.
5. Finish: Red-enamel factory finish, suitable for outdoor use.
6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Water-Flow Indicators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ADT Security Services, Inc.
 - b. McDonnell & Miller; ITT Industries.
 - c. Potter Electric Signal Company.
 - d. System Sensor; a Honeywell company.
 - e. Viking Corporation.
 - f. Watts Industries (Canada) Inc.
2. Standard: UL 346.
3. Water-Flow Detector: Electrically supervised.
4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
5. Type: Paddle operated.
6. Pressure Rating: 250 psig.
7. Design Installation: Horizontal or vertical.

D. Pressure Switches:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AFAC Inc.
 - b. Barksdale, Inc.
 - c. Detroit Switch, Inc.
 - d. Potter Electric Signal Company.
 - e. System Sensor; a Honeywell company.
 - f. Tyco Fire & Building Products LP.
 - g. United Electric Controls Co.
 - h. Viking Corporation.
2. Standard: UL 346.

3. Type: Electrically supervised water-flow switch with retard feature.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design Operation: Rising pressure signals water flow.

E. Valve Supervisory/ Tamper Switches:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Fire-Lite Alarms, Inc.; a Honeywell company.
 - b. Kennedy Valve; a division of McWane, Inc.
 - c. Potter Electric Signal Company.
 - d. System Sensor; a Honeywell company.
2. Standard: UL 346.
3. Type: Electrically supervised.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design: Signals that controlled valve is in other than fully open position.
6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.9 PRESSURE GAGES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AMETEK; U.S. Gauge Division.
 2. Ashcroft, Inc.
 3. Brecco Corporation.
 4. WIKA Instrument Corporation.
- B. Standard: UL 393.
- C. Dial Size: 3-1/2- to 4-1/2-inch diameter.
- D. Pressure Gage Range: 0- to 250-psig minimum.
- E. Label: Include "WATER" label on dial face.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.
- B. Report test results promptly and in writing.

3.2 SERVICE-ENTRANCE PIPING

- A. Connect sprinkler piping to water-service piping for service entrance to building. Comply with requirements for exterior piping in Section 22 11 13 "Facility Water Distribution Piping."
- B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping. Comply with requirements for backflow preventers in Section 22 11 13 "Facility Water Distribution Piping."
- C. Install shutoff valve, check valve, pressure gage, and drain at connection to water service.

3.3 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
 - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
- B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.
- C. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- D. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- E. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- F. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- G. Install sprinkler piping with drains for complete system drainage.
- H. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- I. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.

- J. Install alarm devices in piping systems.
- K. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.
- L. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.
- M. Fill sprinkler system piping with water.
- N. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 21 05 17 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- O. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 21 05 18 "Escutcheons for Fire-Suppression Piping."

3.4 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

- H. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
 - 1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.
- I. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
- J. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- K. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.5 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- D. Specialty Valves:
 - 1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
 - 2. Alarm Valves: Include bypass check valve and retarding chamber drain-line connection.

3.6 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels.
- B. Install sprinklers into flexible, sprinkler hose fittings and install hose into bracket on ceiling grid.

3.7 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13 and as specified in Section 21 05 53 "Identification for Fire Suppression Piping and Equipment."

- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.8 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Test each double-check, detector-assembly backflow preventer according to authorities having jurisdiction and the device's reference standard.
 - 2. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 4. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
 - 5. Energize circuits to electrical equipment and devices.
 - 6. Verify that equipment hose threads are same as local fire-department equipment.
- C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.9 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers with paint other than factory finish.

3.10 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

3.11 PIPING SCHEDULE

- A. Piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe with grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
- B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.
- C. Standard-pressure, wet-pipe sprinkler system, NPS 2 and smaller, shall be one of the following:
 - 1. Standard-weight, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.

2. Standard-weight, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
- D. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 and larger, shall be the following:
1. Standard-weight, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.12 SPRINKLER SCHEDULE

- A. Use sprinkler types in subparagraphs below for the following applications:
1. Rooms without Ceilings: Upright sprinklers.
 2. Rooms with Suspended Ceilings: Pendent sprinklers
 3. Wall Mounting: Sidewall sprinklers.
- B. Provide sprinkler types in subparagraphs below with finishes indicated.
1. Upright, Pendent and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

END OF SECTION 21 13 13

SECTION 22 05 00 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Definitions, references, and abbreviations.
 - 2. General regulatory requirements.
 - 3. General requirements regarding site/field conditions including existing conditions and field measurements.
 - 4. Sequencing and scheduling including coordination.
 - 5. Definition of design equipment and procedures for consideration of specified equivalents, proposed equivalents, or substitutions.
 - 6. Plumbing requirements for foodservice equipment.
 - 7. Plumbing requirements for laboratory equipment.
 - 8. Transition fittings.
 - 9. Grout.
 - 10. Plumbing demolition.
 - 11. Equipment installation requirements common to equipment sections.
 - 12. Painting and finishing.
 - 13. Concrete bases.
 - 14. Supports and anchorages.

1.3 DEFINITIONS

- A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.
- B. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.
- C. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- D. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- E. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

- F. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- G. Potable Water Outlets: Includes external outlets (hose bibs) and any internal outlets that may be used for drinking or cooking (including food preparation) or potentially used for drinking or cooking. Outlets include:
 - 1. Bubblers/drinking fountains/water coolers/bottle fillers.
 - 2. Classroom sinks.
 - 3. Kitchen sinks.
 - 4. Kitchen kettle filler outlets.
 - 5. Ice machines.
 - 6. Toilet room lavatories.
 - 7. Teachers' lounge sinks.
 - 8. Nurse's office sinks.
 - 9. Hose bibbs.

1.4 SYSTEM DESCRIPTION

- A. Provide complete systems, properly connected, tested, balanced, adjusted, and ready for operation, including all necessary and required controls, safeties, details and accessories, including (but not limited to):
 - 1. Sanitary drainage and vent systems.
 - 2. Storm drainage and roof drainage systems.
 - 3. Water distribution systems.
 - 4. Water heating equipment.
 - 5. Plumbing fixtures.
 - 6. Compressed air system.
 - 7. Natural gas piping systems.
 - 8. Electrical control wiring to equipment furnished in this Contract.
 - 9. Electrical power wiring to equipment furnished in this Contract.
 - 10. Miscellaneous items.

1.5 COORDINATION PROCEDURES

- A. Coordinate construction operations and construction schedule of plumbing work with other contractors in accordance with Section 01 31 00 "Project Management and Coordination" and as modified below.
 - 1. Pre-Installation Conference:
 - a. Attend pre-installation conference. Arrange for all subcontractors to be in attendance.
 - 2. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.

3. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Section 08 31 13 "Access Doors and Frames."
4. Coordinate Plumbing Work with HVAC systems, lighting fixtures, ceiling mounted devices, ceiling heights, materials, structural work, maintenance clearances, and electric code clearance and building systems.
5. Notify Owner's Project Representative and Architect in case of unresolved interferences prior to installation of Plumbing Work.
6. Adjust exact size, location and offsets of pipes to achieve reasonable appearance objectives in open areas without ceilings without increase in Contract Sum.

1.6 COORDINATION DRAWINGS

- A. Comply with requirements of Section 01 31 00 "Project Management and Coordination" and as modified below.
 1. Prepare drawings coordinating Plumbing Work with HVAC systems, lighting fixtures, ceiling mounted devices, ceiling heights, materials, structural work, maintenance clearances, electric code clearance, building systems, existing construction, etc. Provide additional details and sections, as required for clarity, at all places of potential conflict.
 2. Reposition proposed locations of Plumbing systems as required to work within project constraints. Adjust exact size, aspect ratio, location and offsets of piping systems as required. Achieve as specified and other reasonable appearance objectives in open areas without ceilings without increase in Contract Sum.
 3. Review Coordination Drawings and compare them with all other drawings to verify that all Work can be installed without interference. Notify Owner's Project Representative in case of unresolved interferences prior to installation of any work. Revise Coordination Drawings as required to eliminate installation interferences upon direction of Architect.
 4. Indicate areas of unresolved conflicts between Plumbing systems and other building components by highlighting locations on Coordination Drawings and separately listing.
 5. Do not proceed with installation of systems in each area until agreement is reached with all concerned on exact arrangements for each room or area, unless otherwise directed by Architect. If Contractor proceeds with installations prior to resolving conflicts, Contractor shall modify installed Work as required to permit other systems to proceed with a coordinated installation without an increase in Contract Sum.
 6. Coordination Drawings do not relieve Contractor of responsibility for coordinating Plumbing system installations with Project work, nor does it authorize extra cost, omission or deviation from Contract Document requirements. Costs arising from errors or omissions in Coordination Drawings shall be borne by Contractor.

1.7 SUBMITTALS, GENERAL

- A. Comply with requirements of SECTION 01 33 00 “Submittal Procedures” for each individual Section and as modified below.
- B. Submit all action submittals required by individual Section concurrently.
 - 1. As-Specified Products: If product to be incorporated into Project is as specified by name and product designation in Part 2 of product specification, and will be installed as specified in Part 3, and only where allowed as such in submittal portion of product specification, then submit “**As-Specified Verification Form**” (attached to SECTION 01 33 00 “Submittal Procedures”) in lieu of “Product Data” identified in the Action Submittal.
 - 2. Do not use “**As Specified Verification Form**” unless specifically indicated in detailed product specification.
 - 3. Equivalent Products or Substitutions: If product to be incorporated into Project is not specified by name and product designation in Part 2 below, comply with all Product Data requirements specified.

1.8 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for sleeves and sleeve seals. Include rated capacities, and furnished specialties and accessories.
 - 1. Penetration firestopping materials.
 - 2. Penetration firestopping assembly drawings.

1.9 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings.
- B. Lab results for lead testing prior to commencing work.
- C. Contract Closeout Submittals: Comply with requirements of Section 01 77 00 “Closeout Procedures”.

1.10 QUALITY ASSURANCE.

- A. Provide installation, testing and materials in accordance with Federal, State and Local Building, Health, Plumbing and Electrical Codes, Laws, Ordinances, and Regulations that apply to Plumbing Work.
 - 1. Comply with applicable requirements of following documents:
 - a. New York State Uniform Fire Prevention and Building Code.
 - b. 2020 Building Code of New York State.
 - c. 2020 Fire Code of New York State.
 - d. 2020 Plumbing Code of New York State.
 - e. 2020 Mechanical Code of New York State.

- f. 2020 Fuel Gas Code of New York State.
 - g. 2020 Energy Conservation Construction Code of New York State.
 - h. New York State Education Department Manual of Planning Standards.
 - i. In event of a conflict between the Codes identified above and Contract Documents, comply with more stringent requirement.
- 2. Comply with applicable Utility Company Regulations.
- 3. Obtain and pay for necessary inspections, certificates, and permits from applicable agencies. Perform required tests in accordance with regulation of agency having jurisdiction. Submit certificates of approval prior to the date of Substantial Completion as defined in Section 01 77 00 "Closeout Procedures".
- B. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code-Steel."
- C. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- D. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is submitted to the Architect and approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Packing and Shipping: Ship materials in manufacturer's containers, fully identified with manufacture's name, trade name, type, class, style, model, grade, size and color.
- C. Storage and Protection:
 - 1. Store materials, equipment, fixtures, pipe, fittings, and attachments, under cover, off ground in original containers as applicable, and protect from physical and weather damage while in storage and during construction.
 - 2. Furnish extra materials identified in technical sections, in original manufacturers' containers and packaging, to Owner at location identified during prebid conference. Obtain receipt from Owner upon delivery of extra materials and send copy of receipt to Architect.

3. Replace or repair damaged, rusted, corroded or otherwise unusable materials physically damaged or weather damaged equipment as determined by Architect, at no change in Contract Sum.
4. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.12 PROJECT/SITE CONDITIONS

A. Existing Conditions:

1. Potable water testing for lead prior to commencing any work: A baseline for lead testing must be set. Coordinate with Owner to schedule potable water lead testing in each building where modifications to the potable water outlets are to take place.
2. Engage a qualified laboratory to test water samples from all potable water outlets scheduled for replacement in accordance with NYS Law 10 CRR-NY 67-4.

B. Take note of any existing potable water outlets scheduled for replacement that exceed the action level (5 micrograms per liter) according to NYS Law 10 CRR-NY 67-4.

C. Rodent Proofing:

1. Strainer Plates: All strainer plates on drain inlets shall be designed and installed so that all openings are not greater than a 1/2 inch in least dimension. Refer to Section 22 13 19 "Sanitary Waste Piping Specialties" and 22 14 23 "Storm Drainage Piping Specialties" for additional requirements.
2. Openings for Pipes: In or on structures where openings have been made in walls, floors or ceilings for the passage of pipes, such openings shall be closed and protected by the installation of approved metal collars that are securely fastened to the adjoining structure. Refer to Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing piping" and 22 05 18 "Escutcheons for Plumbing Piping" for additional requirements.

D. Protection of Plumbing Systems:

1. Corrosion: Provide corrosion protection for pipes passing through concrete or cinder walls and floors or buried in corrosive soil conditions.
 - a. Provide oversized sleeves or core drilled holes to eliminate rubbing on above grade piping installations. Refer to Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping" for pipe sleeve and core drilling requirements.
 - b. Refer to individual Division 22 piping Sections for corrosion protection on buried piping installations in corrosive soil conditions.

2. Stress and Strain: Install plumbing systems in a manner that prevents stresses and strains that exceed the structural strength of the pipe. Install piping systems to accommodate expansion, contraction and structural settlement.
 - a. Provide plastic grommets on pipes running horizontally through metal studs to eliminate rubbing on above grade piping installations. Refer to Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment" for plastic grommet requirements.
3. Freezing: Do not install water, soil, waste or storm piping outside of a building, in attics or crawlspaces, conceal in outside walls or in any other place subjected to freezing temperatures without providing measures to keep the contents of the piping system from freezing.

E. Field Measurements:

1. Layout of equipment, piping, and similar components in Drawings is diagrammatic. Review Drawings to identify interference with other construction and verify dimensions at Site prior to beginning installation.
 - a. Obtain exact location of all items and openings and confirm all existing conditions in field.
 - b. Obtain exact location and roughing requirements for all equipment furnished by others, but installed by this Contractor before roughing. Owner reserves right to make reasonable changes prior to "roughing-in" without increase in Contract Sum.
2. Report any conflicts to Architect in writing before beginning installation.
3. Provide fittings, horizontal and vertical offsets, elevation changes, etc. required to install Plumbing Work. Do not infer that Drawings show level of detail indicating every offset, elbow, union, fitting, elevation changes, or other aspect required for complete installation.
4. Install Plumbing Work with proper provisions for removal and/or access to valves, traps, cleanouts, etc.

1.13 SEQUENCING AND SCHEDULING

- A. Perform Plumbing Work in cooperation with Owner, Architect, Construction Manager, and all Contractors on this Project, and other separate Contractors at the Site.
1. Coordinate Plumbing Work with construction schedule requirements in Division 01
 2. Coordinate all submittals with the construction schedule and with requirements and schedules contained in Section 01 33 00 "Submittals Procedures."
 3. Immediately report any delays in receipt of materials required for Plumbing Work including circumstances causing delays.

- B. Refer to Division 01 for cooperation between Contractors. Prior to start of construction:
1. Obtain from Contract Drawings or Architect, exact location of items and openings in construction. Conform to existing conditions in field.
 2. Review applicable Shop Drawings of all Contracts.
 3. If conflict occurs between Contract Drawings, advise Architect in writing before beginning installation and comply with Architect's directions.
 4. Obtain exact location and roughing requirements for equipment furnished by other Contractor or by Owner but installed by Contractor responsible for Plumbing Work before beginning roughing.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Minimum Material Requirements:
1. Construct potable water systems and equipment according to AWWA standards.
 2. Provide electrical equipment and systems meeting UL standards and requirements of NEC.
 3. Provide UL label on all equipment and material with listing service.
 4. Material Flammability:
 - a. Flame spread rating of 25 or less.
 - b. Smoke developed rating of 50 or less.
 5. Equipment Verification: Carefully check manufacturer's drawings and specifications as they affect their equipment; follow factory instructions for roughing, installation, connection, filling, lubrication, testing, balancing, adjusting, alignment, wiring, and start-up operation.

2.2 CONCRETE BASES AND SUPPORTS

- A. Comply with requirements for concrete bases and supports specified in Section 03 30 00 "Cast-in-Place Concrete".
- B. Equipment Bases: 3-1/2 inches thick minimum, reinforced with 6x6-W1.4xW1.4 welded wire mesh, minimum 1-1/2 inches cover, doubled over 12 inches on long edges, unless otherwise specified.

2.3 GROUT

- A. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000 psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.4 SEALANTS

- A. Comply with requirements for sealants in non-fire rated penetrations specified in Section 07 92 00 "Joint Sealants."
- B. Silicone Sealant, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant.
- C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. GE Construction Sealants; Momentive Performance Materials Inc.
 - 2. Sherwin-Williams Company (The).
 - 3. Sika Corporation.
 - 4. The Dow Chemical Company.
- D. Standard: ASTM C920, Type S, Grade NS, Class 25, Use NT.

2.5 PENETRATION FIRESTOPPING

- A. Comply with requirements for sealants in fire rated penetrations specified in Section 07 84 13 "Penetration Firestopping".
- B. Submit Manufacturers Product Data Sheets for each type of product selected. Certify that Firestop Material is free of asbestos and lead paint and complies with local regulations.
 - 1. Certification by firestopping manufacturer that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs) and are nontoxic to building occupants.
- C. Submit system design listings, including illustrations from qualified testing and inspection agency that is applicable to each firestop configuration.
- D. Submit a project specific Penetration Firestopping Schedule indicating where each firestop configuration will be used.

2.6 ACCESS DOORS

- A. Comply with requirements for access doors specified in Section 08 31 13 "Access Doors and Frames" for product requirements.

B. Access Door Sizes for Plumbing Applications:

1. Single Valve:
 - a. 1 NPS and Smaller Valve Size: 8 inches by 8 inches.
 - b. 1-1/2 NPS and 2 NPS Valve Size: 12 inches by 12 inches.
 - c. 3 NPS and 4 NPS Valve Size: 18 inches by 18 inches.
2. Two Valves:
 - a. 2 NPS and Smaller Valve Size: 12 inches by 12 inches.
 - b. 3 NPS and 4 NPS Valve Size: 18 inches by 18 inches.
3. Condensate Drain Connection: 18 inches by 18 inches.
4. Other Devices: 12 inches by 12 inches.

2.7 PAINT AND FINISHES

- A. Refer to Section 09 91 00 "Painting" for interior and Section 09 96 00 "High-Performance Coatings" for exterior painting and finishing of plumbing piping, equipment and systems.

2.8 FOODSERVICE EQUIPMENT AND FIXTURES

- A. Refer to Section 11 40 00 "Foodservice Equipment" for foodservice equipment and fixtures requiring plumbing piping rough-ins and connections.
- B. Provide plumbing piping rough-ins and connections to food service fixtures and equipment.
- C. Provide plumbing piping rough-ins and connections to relocated food service fixtures and equipment.
- D. Verification of Locations and Dimensions
1. New Equipment: Verify exact locations and roughing-in dimensions for each connection and installation from equipment shop drawings furnished by Contractor Responsible for Kitchen Equipment before beginning installation and provide required adjustments to locations or dimensions.
 2. Relocated Equipment: Verify exact locations and roughing-in dimensions for each connection and installation of relocated equipment and fixtures by inspecting existing installations prior to removal and relocation. Disconnect existing equipment to be relocated or removed.
- E. Provide final plumbing connections to kitchen equipment including interconnecting and final hook-up of plumbing fixtures and piping, valves, traps, fittings, shutoff valves etc. required for complete and operating system.

- F. Install loose plumbing devices, i.e. faucets, pressure regulators relief valves, vacuum breakers, strainers, drains, etc. furnished with kitchen equipment and fixtures at locations indicated on approved equipment shop drawings and equipment product data sheets submitted by Contractor Responsible for Kitchen Equipment. Obtain receipt of delivery for materials supplied by Prime Contractor(s).
- G. Provide indirect waste from kitchen equipment and fixtures at locations indicated on equipment shop drawings and equipment product data sheets submitted by Contractor Responsible for Kitchen Equipment. Obtain receipt of delivery for materials supplied by Prime Contractor(s). Route indirect waste to floor drains or floor sinks with air gap at terminus.
- H. Verify exact locations and roughing-in dimensions for each connection and installation from Roughing Drawings and Assembly Drawings of kitchen equipment accepted by Architect before beginning installation. Obtain Roughing Drawings and Assembly Drawings from Contractor Responsible for Kitchen Equipment Installation.
- I. Install plumbing rough-ins as required for complete and operable installation meeting installation guidelines established by equipment manufacturer.
- J. Install accessible plumbing systems and components in locations and arrangement to allow for regular cleaning of surfaces. Do not support piping from floor where regular cleaning is required.
- K. Maintain 6-inch clear space between floor and plumbing piping, valves, fitting, devices to aid in cleaning floors. Provide supports to bracing piping from walls or equipment.

2.9 LABORATORY EQUIPMENT AND FIXTURES

- A. Refer to Section 12 32 13 "Manufactured Wood-Veneer-Faced Casework" for laboratory equipment and fixtures requiring plumbing piping rough-ins and connections.
- B. Provide plumbing piping rough-ins, traps, drains, supplies with stops and escutcheon plates for connections to fixtures and equipment provided in Section 12 32 13 "Manufactured Wood-Veneer-Faced Casework".
- C. Provide chrome plating on exposed metallic water and gas piping, valves, etc.
- D. Install sink drains and tailpieces furnished by Section 12 32 13 "Manufactured Wood-Veneer-Faced Casework". Obtain receipt of delivery for materials supplied by other Prime Contractors.
- E. Install emergency eye wash equipment fittings and fixtures, i.e. eye wash, sink drains, tailpieces, etc. Obtain receipt of delivery for materials supplied by other Prime Contractors.
- F. Install emergency eyewash and shower equipment fittings and fixtures, i.e. sink drains, eyewash shower head, tailpieces, etc. Obtain receipt of delivery for materials supplied by other Prime Contractors.
- G. Coordinate size, location and number of hole punches required for installation of plumbing faucets and counter mounted turrets with Laboratory Equipment Installer in ample time for holes to be indicated on Roughing Drawings and Assembly Drawing from Laboratory Equipment Installer and Casework Installer.

- H. Verify exact locations and roughing-in dimensions for each connection and installation from Roughing Drawings and Assembly Drawings of laboratory casework and equipment accepted by Architect before beginning installation. Obtain Roughing Drawings and Assembly Drawings from Laboratory Equipment Installer and Casework Installer.
- I. Adjust rough in as required for complete and operable installation meeting installation guidelines established by equipment manufacturer.

2.10 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.

1. Dielectric Unions:

- a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- 1) Capitol Manufacturing Company.
- 2) Central Plastics Company.
- 3) Hart Industries International, Inc.
- 4) Jomar International Ltd.
- 5) Matco-Norca, Inc.
- 6) McDonald, A. Y. Mfg. Co.
- 7) Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- 8) Wilkins; a Zurn company.

- b. Description:

- 1) Standard: ASSE 1079.
- 2) Pressure Rating: 125 psig minimum at 180 deg F.
- 3) End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. Capitol Manufacturing Company.
- b. Central Plastics Company.
- c. Matco-Norca, Inc.
- d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- e. Wilkins; a Zurn company.

2. Description:

- a. Standard: ASSE 1079.
- b. Factory-fabricated, bolted, companion-flange assembly.
- c. Pressure Rating: 125 psig minimum at 180 deg F.
- d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. Advance Products & Systems, Inc.
- b. Calpico, Inc.
- c. Central Plastics Company.
- d. Pipeline Seal and Insulator, Inc.

2. Description:

- a. Nonconducting materials for field assembly of companion flanges.
- b. Pressure Rating: 150 psig.
- c. Gasket: Neoprene or phenolic.
- d. Bolt Sleeves: Phenolic or polyethylene.
- e. Washers: Phenolic with steel backing washers.

2.11 TRANSITION FITTINGS

A. General Requirements:

- 1. Same size as pipes to be joined.
- 2. Pressure rating at least equal to pipes to be joined.
- 3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Coupling: AWWA C219.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. Cascade Waterworks Manufacturing.
- b. Dresser, Inc.; Piping Specialties Products.
- c. Ford Meter Box Company, Inc. (The).
- d. JCM Industries.
- e. Romac Industries, Inc.

- f. Smith-Blair, Inc.; a Sensus company.
 - g. Viking Johnson.
 - 2. Description: Metal, bolted, sleeve-type, reducing or transition coupling, with center sleeve, gaskets, end rings, and bolt fasteners, and with ends of same sizes as piping to be joined.
 - 3. Standard: AWWA C219.
 - 4. Center-Sleeve Material: Manufacturer's standard.
 - 5. Gasket Material: Natural or synthetic rubber.
 - 6. Pressure Rating: 150 psig minimum.
 - 7. Metal Component Finish: Corrosion-resistant coating or material.
- D. Plastic-to-Metal Transition Fittings:
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Charlotte Pipe and Foundry Company.
 - b. Harvel Plastics, Inc.
 - c. Spears Manufacturing Company.
 - 2. Description:
 - a. CPVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.
 - b. One end with threaded brass insert and one solvent-cement-socket or threaded end.
- E. Plastic-to-Metal Transition Unions:
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Colonial Engineering, Inc.
 - b. NIBCO Inc.
 - c. Spears Manufacturing Company.
 - 2. Description:
 - a. CPVC four-part union.
 - b. Brass or stainless-steel threaded end.
 - c. Solvent-cement-joint or threaded plastic end.
 - d. Rubber O-ring.
 - e. Union nut.

PART 3 - EXECUTION

3.1 PROJECT/SITE CONDITIONS

A. Perform the following tests and inspections:

1. Lead Testing Prior to Commencing Construction:

- a. Engage a qualified laboratory to collect and test water samples from all potable water outlets scheduled for replacement in accordance with NYS Law 10 CRR-NY 67-4.
- b. Collect a first-draw sample from a cold-water outlet at each potable water outlet in the building where outlets are scheduled to be replaced as a part of this Contract.
- c. Have samples analyzed for lead content by a State Certified testing lab approved to perform such analyses by the Department's Laboratory Approval Program (ELAP). Submit copy of results to Owner and Architect/Engineer as a base line of water quality in the building before construction.
 - 1) Notify Owner and Architect in writing of any potable water outlets that exceed the lead action level (5 micrograms per liter).

2. Lead Testing After Construction is Complete:

- a. Engage a qualified laboratory to collect and test water samples in accordance with NYS Law 10 CRR-NY 67-4.
- b. Collect a first-draw sample from all potable water outlets in the building where outlets were replaced or added as a part of this Contract.
- c. Have samples analyzed for lead content by a State Certified testing lab approved to perform such analyses by the Department's Laboratory Approval Program (ELAP). Submit copy of results to Owner and Architect/Engineer.
 - 1) Notify Owner and Architect in writing of any potable water outlets that exceed the lead action level (5 micrograms per liter).
- d. Potable water outlets replaced under this contract that exceed the lead action level (5 micrograms per liter):
 - 1) Compare to the levels recorded prior to construction. If levels are increased from pre-construction levels, replace faucets and/or supply stops with new materials, and retest portion thereof until sample results are at or below the preconstruction level.
 - 2) Notify Owner and Architect in writing of any potable water outlets that continue to exceed the lead action level (5 micrograms per liter).
 - 3) Coordinate with the Owner and Architect to implement a Remedial Action Plan to mitigate the lead level at the outlet. Such additional efforts will be performed under the Plumbing Allowance.

- e. Newly installed potable water outlets that exceed the lead action level (5 micrograms per liter):
 - 1) Replace faucets and/or supply stops with new materials, and retest portion thereof until sample results are below the lead action level (5 micrograms per liter).
 - 2) Notify Owner and Architect in writing of any potable water outlets that continue to exceed the lead action level (5 micrograms per liter).
 - 3) Coordinate with the Owner and Architect to implement a Remedial Action Plan to mitigate the lead level at the outlet.

3.2 PLUMBING DEMOLITION

- A. Refer to Section 02 41 19 "Selective Structure Demolition" for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove plumbing systems, equipment, and components indicated to be removed.
 - 1. Remove Piping: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - 2. Abandon Piping in Place: Drain piping and cap or plug piping with same or compatible piping material.
 - 3. Remove Equipment: Disconnect and cap services and remove equipment.
 - 4. Remove and Reinstall Equipment: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - 5. Remove and Salvage Equipment: Disconnect and cap services and remove equipment and deliver to Owner.
- C. If pipe, insulation, or equipment to remain is damaged in appearance or is rendered unserviceable during the process of demolition, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.3 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Unless specific mounting heights are indicated, install equipment to allow maximum possible headroom.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.4 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 Sections, Section 22 05 29 “Hangers and Supports for Plumbing Piping and Equipment” for detailed additional requirements.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.5 CONCRETE BASES

- A. Refer to individual Division 22 piping and equipment Sections for specific concrete base and support requirements.

3.6 GROUTING

- A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

3.7 SEALANTS

- A. Install sealants according to the requirements specified in Section 07 92 00 "Joint Sealants.”
- B. Refer to individual Division 22 plumbing fixture and equipment Sections for specific sealant and caulking requirements.

3.8 FIRESTOPPING

- A. Install firestopping according to the requirements specified in Section 07 84 13 “Penetration Firestopping.”
- B. Applied Fireproofing:
 - 1. Coordinate the installation of hangers, supports and accessories from the structural steel with the fireproofing installation. Install all hangers and supports prior to installation of fireproofing.

2. Repair or replace existing fireproofing removed as a part of Plumbing Work installation.
 - a. Employ the services of an approved fireproofing contractor to repair or replace the fireproofing by patching any areas that have been removed or damaged due to the installation of work after the completion of the fireproofing.
 - b. Repaired or replacement fireproofing shall match the fireproofing adjacent to the repaired area. All warranties shall be maintained.

3.9 ACCESS DOORS

- A. Install access doors according to the requirements specified in Section 08 31 13 "Access Doors and Frames."
- B. Install access doors where shown on Drawings or where required for access to plumbing system components requiring service (i.e. valves, equipment, slip joints, unions, gauges, etc.) and are located in concealed installations.

3.10 PAINTING

- A. Painting of plumbing systems, equipment, and components is specified in Section 09 91 00 "Painting."
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.11 DIELECTRIC FITTINGS

- A. Install dielectric fittings according to the specific requirements in the Division 22 Sections specifying piping systems.

3.12 TRANSITION FITTINGS

- A. Install transition fittings according to the specific requirements in the Division 22 Sections specifying piping systems.

END OF SECTION 22 05 00

SECTION 22 05 17 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING**PART 1 - GENERAL****1.1 SUMMARY****A. Section Includes:**

1. Sleeve-seal systems.
2. Grout.
3. Silicone sealants.

1.2 ACTION SUBMITTALS**A. Product Data:** For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for sleeves seals.

1. Sleeve-seal systems.
2. Firestopping.

PART 2 - PRODUCTS**2.1 SLEEVES WITHOUT WATERSTOP**

- A. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron, with plain ends.
- B. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, hot-dip galvanized, with plain ends.
- C. Steel Sheet Sleeves: ASTM A653/A653M, 24 gauge minimum thickness; hot-dip galvanized, round tube closed with welded longitudinal joint

2.2 SLEEVES WITH WATERSTOP

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Advance Products & Systems, LLC.
 2. CALPICO, Inc.
 3. GPT; an EnPro Industries company.
 4. Metraflex Company (The).
- B. Description: Manufactured galvanized steel, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall.

2.3 STACK-SLEEVE FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Jay R. Smith Mfg Co; a division of Morris Group International.
 - 2. Wade; a subsidiary of McWane Inc.
 - 3. Zurn Industries, LLC.
- B. Description: Manufactured, Dura-coated or Duco-coated galvanized cast-iron sleeve with integral clamping flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with setscrews.

2.4 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Advance Products & Systems, LLC.
 - 2. CALPICO, Inc.
 - 3. GPT; an EnPro Industries company.
 - 4. Metraflex Company (The).
 - 5. Proco Products, Inc.
- B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - 1. Designed to form a hydrostatic seal of 20 psig minimum.
 - 2. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 3. Sealing Elements (Natural Gas and Propane Gas Systems): NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 4. Pressure Plates: Stainless steel, Type 316.
 - 5. Connecting Bolts and Nuts: Stainless steel, Type 316 of length required to secure pressure plates to sealing elements.

2.5 PENETRATION FIRESTOPPING

- A. Comply with requirements for sealants in fire rated penetrations specified in Section 07 84 13 "Penetration Firestopping" and Section 22 05 00 "Common Work Results for Plumbing."

2.6 GROUT

- A. Refer to grout product requirements specified in Section 22 05 00 "Common Work Results for Plumbing."

2.7 SILICONE SEALANTS

- A. Comply with requirements for silicone sealants specified in Section 07 92 00 "Joint Sealants" and Section 22 05 00 "Common Work Results for Plumbing."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 INSTALLATION OF SLEEVES - GENERAL

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
 - 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
 - 2. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
 - 3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Run pipe insulation continuously through sleeve.
 - 3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 4. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.
- E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 07 84 13 "Penetration Firestopping."

3.3 INSTALLATION OF SLEEVES WITH WATERSTOP

- A. Install sleeve with waterstop as new walls and slabs are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeves. Select to maintain fire resistance of floor/slab/wall.

3.4 INSTALLATION OF STACK-SLEEVE FITTINGS

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
 - 1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing.
 - 3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
 - 4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 5. Using waterproof silicone sealant, seal space between top hub of stack-sleeve fitting and pipe.
- B. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping specified in Section 07 84 13 "Penetration Firestopping."

3.5 INSTALLATION OF SLEEVE-SEAL SYSTEMS

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building and passing through exterior walls.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Assemble sleeve-seal system components and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.6 SLEEVE SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above and below Grade:
 - a. Sleeves with waterstops.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
2. Concrete Slabs-on-Grade:
 - a. Sleeves with waterstops.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
3. Concrete Slabs above Grade:
 - a. Sleeves with waterstops or stack-sleeve fittings.
4. Interior Partitions:
 - a. Sleeves without waterstops.

END OF SECTION 22 05 17

SECTION 22 05 18 - ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes escutcheons and floor plates.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. BrassCraft Manufacturing Co.; a Masco company.
 - 2. Dearborn Brass.
 - 3. Jones Stephens Corp.
 - 4. Keeney Manufacturing Company (The).
 - 5. ProFlo; a Ferguson Enterprises, Inc. brand.
- B. Escutcheon Types:
 - 1. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
 - 2. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished, chrome-plated finish and spring-clip fasteners.
 - 3. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.
 - 4. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed hinge; and spring-clip fasteners.

2.2 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
- B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 INSTALLATION

- A. Install escutcheons for exposed piping penetrations of walls, ceilings, and finished floors.

3.3 ESCUTCHEONS APPLICATION

- A. Escutcheons for New Piping and Relocated Existing Piping:
 - 1. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
 - 2. Chrome-Plated Piping: One piece, cast brass with polished, chrome-plated finish.
 - 3. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
 - 4. Bare Piping at Wall, Floor or Ceiling Penetrations in Finished Spaces: One piece, cast brass or split-casting brass type with polished, chrome-plated finish.
 - 5. Bare Piping in Unfinished Service Spaces or Equipment Rooms: One piece, stamped steel or split plate, stamped steel with concealed hinge with polished, chrome-plated finish.
- B. Escutcheons for Existing Piping (only required where impacted by new walls, floors or ceilings):
 - 1. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
 - 2. Insulated Piping: Split-plate, stamped-steel type with concealed hinge.
 - 3. Bare Piping at Wall, Floor or Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
 - 4. Bare or Insulated Piping in Unfinished Service Spaces and Equipment Rooms: No escutcheons required.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. New Piping: One-piece, floor-plate type.
 - 2. Existing Piping: Split-casting, floor-plate type.

3.4 FIELD QUALITY CONTROL

- A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 22 05 18

SECTION 22 05 19 - METERS AND GAUGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Thermometers.
 - 2. Gauges.
 - 3. Test plugs and kits.

1.3 SUBMITTALS, GENERAL

- A. General: Submit all action submittals required by this Section concurrently.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for sleeves and sleeve seals. Include rated capacities, and furnished specialties and accessories.
 - 1. Test plugs.
 - 2. Test plug kits.
- B. As-Specified Data: If the product to be incorporated in the Work is as specified by manufacturer name and product designation in this Specification Section, submit the “**As-Specified Verification Form**” (attached to Section 01 33 00 “Submittal Procedures”) for each item listed below; otherwise submit full Product Data for the following:
 - 1. Liquid-in-glass thermometers.
 - 2. Thermowells.
 - 3. Dial-type pressure gauges.
 - 4. Snubbers.
 - 5. Valves.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of gauge to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Domestic water for plumbing piping intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act, with requirements of authorities having jurisdiction, and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.
- B. Compatibility: Provide products suitable for piping service fluids, materials, working pressures, and temperatures.

2.2 THERMOMETERS, LIQUID IN GLASS, LEAD FREE - PLASTIC CASE, INDUSTRIAL STYLE

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Weiss Instruments, Inc; Vari-angle Model 9VU Series or a comparable product by one of the following:
 - 1. Ernst Flow Industries.
 - 2. WATTS; A Watts Water Technologies Company.
- B. Source Limitations: Provide liquid-in-glass, lead-free, plastic-case, industrial-style thermometers from single manufacturer.
- C. Standard: ASME B40.200.
- D. Case: GE Valox® polyester, 40 percent glass/mineral reinforced; 9-inch nominal size unless otherwise indicated.
- E. Case Form: Adjustable angle unless otherwise indicated.
- F. Tube: Glass with magnifying lens and blue organic liquid, mercury free.
- G. Tube Background: Nonreflective aluminum with permanent scale markings graduated in deg F.
- H. Window: Glass.
- I. Stem: Aluminum, lead-free brass, or stainless steel and of length to suit installation.
 - 1. Design for Thermowell Installation: Bare stem.
- J. Connector: 1-1/4 inches, with ASME B1.1 or ASME B1.20.1 screw threads to fit thermowell.
- K. Accuracy: Plus or minus 1 percent of span or one scale division, to a maximum of 1.5 percent of span.

2.3 THERMOWELLS, LEAD FREE

- A. Standard: ASME B40.200.
- B. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
- C. Material for Use with Copper Tubing: Lead-free copper.
- D. Material for Use with Steel Piping: Type 304 stainless steel.
- E. Type: Stepped shank unless straight or tapered shank is indicated.
- F. External Threads: NPS 1/2, NPS 3/4, or NPS 1, or as required to match threaded opening in pipe.
- G. Internal Threads: Size and thread type as required to match thermometer mounting threads.
- H. Bore: Diameter required to match thermometer bulb or stem.
- I. Insertion Length: Length to extend to match thermometer stem length.
- J. Lagging Extension: Include on thermowells for insulated piping and tubing. Extension is to be of sufficient length to extend beyond finished insulation surface.
- K. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
- L. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.4 PRESSURE GAUGES, DIAL TYPE, LEAD FREE - DIRECT MOUNTED, METAL CASE

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Weiss Instruments, Inc; Series 4CTSLF or a comparable product by one of the following:
 - 1. Ernst Flow Industries.
 - 2. Tel-Tru Manufacturing Company.
 - 3. Trerice, H. O. Co.
- B. Source Limitations: Provide dial-type, lead-free, direct-mounted, metal-case pressure gauges from single manufacturer.
- C. Standard: ASME B40.100.
- D. Case: Liquid-filled, sealed solid-front, pressure-relief type(s); stainless-steel; 4-1/2-inch nominal diameter.
- E. Pressure-Element Assembly: Lead-free Bourdon tube.
 - 1. Pressure Connection: Lead-free brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
 - 2. Movement: Mechanical, with link to pressure element and connection to pointer.
 - 3. Dial: White coated metal lithographed with black scale markings graduated in psi.
 - 4. Pointer: Dark-colored metal.
 - 5. Window: Safety glass lens.
 - 6. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.5 GAUGE ATTACHMENTS, LEAD FREE

- A. Snubbers: ASME B40.100, lead-free brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston or porous-metal-type surge-dampening device. Include extension for use on insulated piping.

- B. Valves: Lead-free brass or stainless-steel quarter turn ball valve, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

2.6 TEST PLUGS, LEAD FREE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Trerice, H. O. Co.
 - 2. WATTS; A Watts Water Technologies Company.
 - 3. Weiss Instruments, Inc.
- B. Source Limitations: Provide lead-free test plugs from single manufacturer.
- C. Description: Test-station fitting made for insertion into piping tee fitting.
- D. Body: Lead-free brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
- E. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.
- F. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
- G. Core Inserts: EPDM self-sealing rubber.

2.7 TEST-PLUG KITS, LEAD FREE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Trerice, H. O. Co.
 - 2. WATTS; A Watts Water Technologies Company.
 - 3. Weiss Instruments, Inc.
- B. Source Limitations: Provide lead-free test-plug kits from single manufacturer.
- C. Furnish one test-plug kit(s) containing one thermometer(s), one pressure gauge and adapter, and carrying case. Thermometer sensing elements, pressure gauge, and adapter probes are to be of diameter to fit test plugs and of length to project into piping.
- D. High-Range Thermometer, Lead Free: Small, bimetallic insertion type with 1- to 2-inch-diameter dial and tapered-end sensing element. Dial range is to be at least 0 to 220 deg F.
- E. Pressure Gauge, Lead Free: Small, lead-free Bourdon-tube insertion type with 2- to 3-inch-diameter dial and probe. Dial range is to be at least 0 to 200 psig.
- F. Carrying Case: Metal or plastic, with formed instrument padding.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 INSTALLATION OF METERS AND GAUGES

- A. Install thermometer with thermowell at each required thermometer location.
- B. Install thermowells in vertical position in piping tees.
- C. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- D. Install thermowells with extension on insulated piping.
- E. Fill thermowells with heat-transfer medium.
- F. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- G. Install direct-mounted pressure gauges in piping tees with pressure gauge located on pipe at most readable position.
- H. Install valve and snubber in piping for each pressure gauge for fluids.
- I. Install test plugs in piping tees.

3.3 CONNECTIONS

- A. Install meters and gauges adjacent to machines and equipment to allow space for service and maintenance of meters, gauges, machines, and equipment.

3.4 ADJUSTING

- A. After installation, calibrate meters according to manufacturer's written instructions.
- B. Adjust faces of meters and gauges to proper angle for best visibility.

3.5 THERMOMETER, LEAD FREE, APPLICATION

- A. Thermometers at inlet and outlet of each domestic water heater are to be the following:
 - 1. Plastic case, industrial-style, liquid-in-glass type.
- B. Thermometers at inlet and outlet of each domestic hot-water storage tank are to be the following:
 - 1. Plastic case, industrial-style, liquid-in-glass type.
- C. Thermometer stems are to be of length to match thermowell insertion length.

3.6 THERMOMETER, LEAD FREE, SCALE-RANGE APPLICATION

- A. Scale Range for Domestic Water Piping: 30 to 240 deg F.
- B. Insert additional paragraphs for thermometer scale ranges and applications.

3.7 PRESSURE-GAUGE APPLICATION

- A. Pressure gauges at suction and discharge of each domestic water pump are to be the following:
 - 1. Liquid filled, sealed solid front, pressure relief, direct mounted, metal case.

3.8 PRESSURE-GAUGE SCALE-RANGE APPLICATION

- A. Scale Range for Domestic Water Piping:
 - 1. 0 to 100 psi.

END OF SECTION 22 05 19

SECTION 22 05 23 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Ball valves.
 - 2. Butterfly valves
 - 3. Check valves.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Nonrising stem.
- E. OS&Y: Outside screw and yoke.
- F. PTFE: Polytetrafluoroethylene.
- G. RPTFE: Reinforced polytetrafluoroethylene.
- H. RS: Rising stem.
- I. SWP: Steam working pressure.
- J. WOG: Water, oil, gas.

1.4 SUBMITTALS, GENERAL

- A. General: Submit all action submittals required by this Section concurrently.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of valve indicated.
 - 1. Ball valves.
 - 2. Butterfly valves
 - 3. Check valves.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooved ends, press ends, solder ends, and weld ends.
3. Set ball valves open to minimize exposure of functional surfaces.
4. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of valve from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Standards:

1. Domestic-water piping valves intended to convey or dispense water for human consumption must comply with the U.S. Safe Drinking Water Act (SDWA), requirements of authorities having jurisdiction, and NSF 61/NSF 372; or to be certified in compliance with NSF 61/NSF 372 by an American National Standards Institute (ANSI)-accredited third-party certification body, that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded-end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.5 for flanges on steel valves.
4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
5. ASME B16.18 for cast-copper solder-joint connections.
6. ASME B16.22 for wrought-copper solder-joint connections.
7. ASME B16.34 for flanged- and threaded-end connections.
8. ASME B16.51 for press joint connections.
9. ASME B31.9 for building services piping valves.

C. Provide bronze valves made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are unacceptable.

D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

- E. Valve Sizes: Same as upstream piping unless otherwise indicated.
- F. Valve Bypass and Drain Connections: MSS SP-45.
- G. Valve Actuator Type:
 - 1. Hand Lever: For quarter-turn ball valves smaller than NPS 4.
- H. Valves in Insulated Piping:
 - 1. Provide 2-inch extended neck stems.
 - 2. Provide extended operating handles with nonthermal-conductive covering material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
 - 3. Provide memory stops that are fully adjustable after insulation is applied.

2.3 BRONZE BALL VALVES

- A. Bronze Ball Valves, Lead-Free, Two-Piece with Full Port, and Stainless-Steel Trim, Solder or Threaded Ends (NPS 2 and smaller):
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide NIBCO INC.; Model S/T-585-66-LF-NS or a comparable product by one of the following:
 - a. Conbraco Industries, Inc.; Apollo Valves; 70LF-140, 70LF-240.
 - b. Hammond Valve.
 - c. Milwaukee Valve Company.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc; LFB6000-SS, LFB6001-SS.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Two piece.
 - e. Body Material: Bronze.
 - f. Ends: Soldered or threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Type 316 stainless steel.
 - i. Ball: Type 316 stainless steel, vented.
 - j. Port: Full.
 - k. Handle: Insulated extension handle.

B. Bronze Ball Valves, Lead-Free, Two-Piece with Full Port, and Stainless-Steel Trim, Press Ends (NPS 2 and smaller):

1. Basis-of-Design Product: Subject to compliance with requirements, provide NIBCO INC.; Model PC-585-80-LF-NS or a comparable product by one of the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. Hammond Valve.
 - c. Milwaukee Valve Company.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
 - a. Standard: MSS SP-110 or MSS-145.
 - b. CWP Rating: Minimum 200 psig.
 - c. Body Design: Two piece.
 - d. Body Material: Bronze.
 - e. Ends: Press.
 - f. Press Ends Connections Rating: Minimum 200 psig.
 - g. Seats: PTFE or TFE Reinforced PTFE.
 - h. Stem: Bronze or brass.
 - i. Ball: Stainless steel.
 - j. Port: Full.
 - k. O-Ring Seal: EPDM.
 - l. Handle: Insulated extension handle.

C. Three-Piece, Lead-Free, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:

1. Basis-of-Design Product: Subject to compliance with requirements, provide NIBCO INC.; Model S/T-595-Y-66-LF-NS or a comparable product by one of the following:
 - a. Conbraco Industries, Inc.; Apollo Valves.
 - b. Hammond Valve.
 - c. Milwaukee Valve Company.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.; Model LFB6800.
2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Three piece.
 - e. Body Material: Bronze.
 - f. Ends: Soldered or threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Type 316 stainless steel.
 - i. Ball: Type 316 stainless steel, vented.
 - j. Port: Full.
 - k. Handle: Insulated extension handle.

2.4 DUCTILE IRON, SINGLE-FLANGE (LUG-TYPE) BUTTERFLY VALVES

A. Iron, Single-Flange (Lug-Type) Butterfly Valves with Aluminum-Bronze Disc:

1. Basis-of-Design Product: Subject to compliance with requirements, provide NIBCO INC.; LD-2000. or a comparable product by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. Hammond Valve.
 - c. Jenkins Valves; a Crane Co. brand.
 - d. Legend Valve & Fitting, Inc.
 - e. Milwaukee Valve Company.
 - f. Stockham; a Crane Co. brand.
 - g. WATTS.
2. Standard: MSS SP-67, Type I.
3. CWP Rating: 200 psig.
4. Body Design: Single flange (lug type), suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
5. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
6. Seat: EPDM.
7. Stem: One- or two-piece stainless steel.
8. Disc: Aluminum bronze.

2.5 SILICON BRONZE SWING CHECK VALVES

A. Bronze Swing Check Valves with Nonmetallic Disc, Class 125:

1. Basis-of-Design Product: Subject to compliance with requirements, provide NIBCO INC.; T/S/PC-413-Y-LF or comparable product by one of the following:
 - a. Hammond Valve.
 - b. Milwaukee Valve Company.
 - c. WATTS.
2. Description:
 - a. Standard: MSS SP-139.
 - b. CWP Rating: 200 psig (1380 kPa).
 - c. Body Design: Horizontal or vertical (flow in upward direction) flow.
 - d. Body Material: Silicon bronze (ASTM listed), corrosion resistant.
 - e. Ends: Threaded, soldered, or press. See valve schedule articles.
 - f. Disc: PTFE.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.
- F. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 INSTALLATION OF VALVES

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
- F. Valve Tags: Comply with requirements in Section 22 05 53 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Ball or butterfly valves.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option or press-end option is indicated in valve schedules below.
 - 2. For Steel Piping, NPS 2 and Smaller: Threaded ends.

3.5 LOW-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE (150 PSIG OR LESS)

- A. Pipe NPS 2 and Smaller:
 - 1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
 - 2. Ball Valves: Two piece, full port, bronze with bronze trim.
 - 3. Bronze Swing Check Valves: Class 125, nonmetallic disc.

3.6 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller:
 - 1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
 - 2. Bronze Ball Valves: Two-piece with full port and stainless-steel trim. Provide with threaded, solder or press connection-joint ends.
 - 3. Bronze Ball Valves: Three-piece with full port and stainless-steel trim.
 - 4. Silicon Bronze Swing Check Valves: Class 125, nonmetallic disc.
- B. Pipe NPS 2-1/2 (DN 65) and Larger:
 - 1. Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM seat, aluminum-bronze disc.

END OF SECTION 22 05 23

SECTION 22 05 29 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Thermal hanger-shield inserts.
 - 4. Fastener systems.
 - 5. Roof mounted pipe stands.
 - 6. Pipe-positioning systems.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for sleeves and sleeve seals. Include rated capacities, and furnished specialties and accessories.
 - 1. Roof mounted pipe stands.
 - 2. Insulation shields.
- B. As-Specified Data: If the product to be incorporated in the Work is as specified by manufacturer name and product designation in this Specification Section, submit the “**As-Specified Verification Form**” (attached to Section 01 33 00 “Submittal Procedures”) for each item listed below; otherwise submit full Product Data for the following:
 - 1. Threaded rod.
 - 2. Adjustable clevis hanger.
 - 3. Adjustable swing-ring band hangers.
 - 4. Adjustable swivel-ring band hangers.
 - 5. Hinged pipe clamps.
 - 6. Pipe stanchion saddles.
 - 7. Adjustable pipe saddle supports.
 - 8. Riser clamps.
 - 9. Beam Clamps.

- C. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:
 - 1. Trapeze pipe hangers.
- D. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Detail fabrication and assembly of trapeze hangers.
 - 2. Include design calculations for designing trapeze hangers.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Pipe Welding Qualifications: Qualify procedures and operators according to 2015 ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design trapeze pipe hangers and equipment supports.
- B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Anvil International; a subsidiary of Mueller Water Products Inc.
 - 2. Cooper B-Line, Inc.
 - 3. ERICO International Corporation.
 - 4. PHD Manufacturing, Inc.

2.3 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized, hot-dip galvanized, or electro-galvanized.
3. Nonmetallic Coatings: Plastic coated or epoxy powder coated.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Copper Pipe and Tube Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel or stainless steel.

2.4 TRAPEZE PIPE HANGERS

- ### A.
- Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly, made from structural-carbon-steel shapes, with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.5 THERMAL HANGER-SHIELD INSERTS

- ### A.
- Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Buckaroos, Inc.
2. CADDY; brand of nVent Electrical plc.
3. Carpenter & Paterson, Inc.
4. Pipe Shields Inc.

- ### B.
- Insulation-Insert Material for Type "B" and "E" Insulated Piping Support Assemblies: ASTM C552, Type II cellular glass with 100-psig or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

- ### C.
- Insulation-Insert Material for Type "C" and "F" Insulated Piping Support Assemblies: Water-repellent-treated, ASTM C533, Type I calcium silicate with 100-psig minimum compressive strength.

- ### D.
- For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

- ### E.
- For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

- ### F.
- Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hilti, Inc.
 - b. ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - c. MKT Fastening, LLC.
 - d. Simpson Strong-Tie Co., Inc.
- B. Mechanical-Expansion Anchors: Insert-wedge-type anchors, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cooper B-line; brand of Eaton, Electrical Sector.
 - b. Empire Tool and Manufacturing Co., Inc.
 - c. Hilti, Inc.
 - d. ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - e. MKT Fastening, LLC.
 - 2. Indoor Applications: Zinc-coated or stainless steel.
 - 3. Outdoor Applications: Stainless steel.

2.7 ROOF MOUNTED PIPE STANDS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. MAPA Products.
 - 2. Miro Industries, Inc.
 - 3. PHD Manufacturing, Inc.
- B. General Requirements for Pipe Stands:
 - 1. Shop-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
 - 2. Gently rounded edges to prevent damage to roof membrane.
 - 3. Drainage ports to prevent ponding.
 - 4. Carbon black additive in polycarbonate, when used, for UV stabilization.

C. Low-Profile, Single-Base, Single-Pipe Stand:

1. Description: Single base with vertical and horizontal members, and pipe support, for roof installation without membrane protection.
2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
3. Vertical Members: Two stainless-steel, continuous-thread, 1/2-inch rods.
4. Horizontal Member: Adjustable horizontal, stainless-steel pipe support channels.
5. Pipe Supports: Roller.
6. Hardware: Stainless steel.
7. Accessories: Protection pads.
8. Height: 12 inches above roof.

D. Protection Pads: 15-3/4 by 19-3/4 inch rectangle, 1/8 inch thick, flexible PVC with carbon black additive for UV stabilization.

2.8 PIPE-POSITIONING SYSTEMS

- A. Description: IAPMO PS 42 positioning system composed of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.9 PLASTIC GROMMETS

- A. Snap-in type plastic grommets for stud webs to protect plumbing piping. Prevent metal-to-metal contact between piping and studs.

2.10 MATERIALS

- A. Carbon Steel: ASTM A1011/A1011M.
- B. Structural Steel: ASTM A36/A36M carbon-steel plates, shapes, and bars; black and galvanized.
- C. Stainless Steel: ASTM A240/A240M.
- D. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
1. Properties: Nonstaining, noncorrosive, and nongaseous.
 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.

- B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A36/A36M carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- D. Thermal Hanger-Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete, after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Pipe Stand Installation:
 - 1. Pipe Stand Types, except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 - 2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 07 72 00 "Roof Accessories" for curbs.
- G. Pipe-Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.
- H. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- I. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- J. Install lateral bracing with pipe hangers and supports to prevent swaying.

- K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- L. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- N. Insulated Piping:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating Below Ambient Air Temperature: Use thermal hanger-shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 39 protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - 5. Thermal Hanger Shields: Install with insulation of same thickness as piping insulation.

3.3 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections, so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ROOF MOUNTED SUPPORT INSTALLATION

- A. Determine that roof structure, roof insulation, and roof membrane are structurally adequate to support weight of pipe, duct, conduit, and supports and hangers.
- B. Install supports and hangers in accordance with manufacturer's recommendations.
- C. Install supports at maximum spacing of 10 feet unless closer spacing is required due to weight of pipe or conduit contents or greater spacing is specifically allowed by manufacturer; space and adjust to support an equal amount of weight; do not exceed manufacturer's recommended load limits.
- D. Install an additional sheet of roofing material, support pad, or deck plate beneath each support base.
- E. Support Pads:
 - 1. Apply support pad on cleaned area.
 - 2. Center bases on top of support pads.
- F. Pipe Supports: Center beneath pipe so that pipe is located squarely over and through cradle or hanger. Set pipe in support without dropping or causing undue impact.
- G. Adjustable Supports: Adjust height of each support to achieve proper height and level before installing supported item.
 - 1. Level rollers or struts before installing pipe.
 - 2. Make final height adjustments to provide even distribution of load on all supports.
- H. Fixed Anchor Supports: Prior to installation of roof decking, insulation and roof membrane attach support to roof structure as indicated on drawings.
 - 1. After installation of roof decking, insulation and membrane, install pipe or roof top mechanical supports used in connection with fixed anchor supports.
 - 2. Install piping or mechanical units on each support.

3.5 PLASTIC GROMMETS

- A. Provide grommets for bare pipes penetrating vertically or horizontally through metal stud knockouts.

3.6 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.7 PAINTING

- A. Touchup: Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- A. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in and Section 09 96 00 "High-Performance Coatings" for interior and exterior installations.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.8 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers and metal framing systems and attachments for general service applications.
- F. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
- G. Use padded hangers for piping that is subject to scratching.
- H. Use thermal hanger-shield inserts for insulated piping and tubing.

- I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Piping in general service applications:
 - a. Piping Installed in Metal Stud Cavities:
 - 1) NPS 1/2 to 3/4: After tubing and continuous insulation passes through the hole in stud or bracket, position the insert around tubing and push insert through the hole until the tabs click and lock into place.
 - b. Bare Copper Piping Systems:
 - 1) NPS 1-1/4 and Smaller: Adjustable, plastic coated copper swivel loop hanger for suspension of non-insulated stationary pipes.
 - 2) NPS 1-1/2 and Larger: Copper plated clevis hanger for suspension of non-insulated stationary pipes. Hanger sized on outside pipe diameter.
 - c. Bare Ferrous Piping Systems:
 - 1) NPS 1-1/4 and Smaller: Heavy duty electro-galvanized steel swivel loop hanger for suspension of non-insulated stationary pipes.
 - 2) NPS 1-1/2 and Larger: Electro-galvanized clevis hanger for suspension of non-insulated stationary pipes. Hanger sized on outside pipe diameter.
 - d. Bare Plastic Piping Systems:
 - 1) NPS 1-1/4 and Smaller: Heavy duty electro-galvanized steel swivel loop hanger for suspension of non-insulated stationary pipes.
 - 2) NPS 1-1/2 and Larger: Electro-galvanized clevis hanger with 12 inches long galvanized steel thermal-hanger shield insert for suspension of non-insulated stationary pipes. Hanger sized on outside pipe diameter.
 - e. Insulated Piping Systems:
 - 1) NPS 2 and Smaller: Electro-galvanized clevis hanger with galvanized steel thermal-hanger shield insert for suspension of insulated stationary pipes. Hanger sized on outside insulation diameter.
 - 2) NPS 2-1/2 and Larger: Electro-galvanized clevis hanger with separate or integral galvanized steel thermal-hanger shield insert for suspension of insulated stationary pipes. Hanger sized on outside insulation diameter.
- J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

- K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
- L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
- M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.

2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
 3. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
- O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- P. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- Q. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 22 05 29

SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Equipment and piping labels.
 - 2. Valve tags and signage.

1.3 SUBMITTALS, GENERAL

- A. General: Submit all action submittals and informational submittals required by this Section concurrently.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Warning signs/labels.
 - 2. Valve function signage.
- B. As-Specified Data: If the product to be incorporated in the Work is as specified by manufacturer name and product designation in this Specification Section, submit the “**As-Specified Verification Form**” (attached to Section 01 33 00 “Submittal Procedures”) for each item listed below; otherwise submit full Product Data for the following:
 - 1. Equipment labels.
 - 2. Pipe labels.
- C. Samples: For color, letter style, and graphic representation required for each identification material and device.
- D. Equipment-Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- E. Valve-numbering scheme.
- F. Valve Schedules: For each piping system. Include in operation and maintenance manuals.

1.5 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Brady, Inc.
 - 2. Craftmark Pipe Markers.
 - 3. Seton, Inc.
- B. Plastic Labels for Equipment:
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, with predrilled holes for attachment hardware.
 - 2. Letter and Background Color: As indicated for specific application under Part 3.
 - 3. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.
 - 4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 - 5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - 6. Fasteners: Stainless steel rivets or self-tapping screws.
 - 7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

2.2 WARNING SIGNS AND LABELS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Brady, Inc.

2. Craftmark Pipe Markers.
 3. Seton, Inc.
- B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, with predrilled holes for attachment hardware.
- C. Letter and Background Color: As indicated for specific application under Part 3.
- D. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Arc-Flash Warning Signs: Provide arc-flash warning signs in locations and with content in accordance with requirements of OSHA and NFPA 70E, and other applicable codes and standards.
- J. Label Content: Include caution and warning information plus emergency notification instructions.
1. Chemical Waste Neutralization Tanks: Text to read "IMPORTANT - BASIN MUST BE INSPECTED FREQUENTLY AND NEUTRALIZING AGENT REPLACED WHEN NECESSARY. FAILURE TO DO SO MAY RESULT IN SERIOUS DAMAGE TO PIPING. TAKE NECESSARY PRECAUTIONS TO PREVENT INJURY DUE TO ESCAPING GASES WHEN OPEN."
 2. Natural Gas piping at utility meter/regulator location serving only the building: "GAS SERVICE FEEDS THE BUILDING."
 3. Grease interceptors: A minimum nominal width of 14 inches and a minimum nominal height of 10 inches and to read as follows:



2.3 PIPE LABELS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Brady, Inc.
 - 2. Craftmark Pipe Markers.
 - 3. Seton, Inc.
- B. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.
- C. Letter and Background Color: As indicated for specific application under Part 3.
- D. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- E. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing and separate self-adhesive direction arrow tape on each end fully wrapped around pipe.
- F. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include:
 - 1. Pipe size.
 - 2. Flow-Direction Arrows: Include flow-direction arrows on main distribution piping. Arrows may be either integral with label or applied separately.
 - 3. Lettering Size: At least 1/2 inch for viewing distances of up to 72 inches and proportionately larger lettering for greater viewing distances.

2.4 STENCILS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Craftmark Pipe Markers.
 - 2. Kolbi Pipe Marker Co.
 - 3. Marking Services Inc.
 - 4. Pipemarker.com; Brimar Industries, Inc.
- B. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.
 - 1. Stencil Material: Aluminum, brass, or fiberboard.
 - 2. Stencil Paint: Exterior, gloss, acrylic enamel in colors complying with recommendations in ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.
 - 3. Identification Paint: Exterior, acrylic enamel in colors in accordance with ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.
 - 4. Letter and Background Color: As indicated for specific application under Part 3.

2.5 VALVE TAGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Brady Corporation.
 - 2. Craftmark Pipe Markers.
 - 3. Kolbi Pipe Marker Co.
 - 4. Marking Services Inc.
 - 5. Pipemarket.com; Brimar Industries, Inc.
 - 6. Seton Identification Products; a Brady Corporation company.
- B. Description: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
 - 1. Tag Material: Brass, 0.04-inch minimum thickness, with predrilled or stamped holes for attachment hardware.
 - 2. Fasteners: Brass link chain or S-hook.
- C. Letter and Background Color: As indicated for specific application under Part 3.
- D. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - 1. Include valve-tag schedule in operation and maintenance data.

2.6 VALVE FUNCTION SIGNAGE

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Brady, Inc.
 - 2. Craftmark Pipe Markers.
 - 3. Seton, Inc.
- B. Plastic Signage:
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
 - 2. Letter Color: White.
 - 3. Background Color: Black.
 - 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
 - 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 7. Fasteners: Stainless-steel rivets or self-tapping screws.
 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- C. Signage Content: Include valve's unique verbiage where indicated on Drawings, unless otherwise specified.
1. Stop and drain valves serving an exterior wall hydrant: Text to read "Wall Hydrant Shutoff Valve and Drain Plug".
 2. Bypass valves: Text to read "Bypass Valve-Normally Closed".
 3. Branch shut-off valves serving emergency fixtures: Text to read "Emergency Fixture-No Unauthorized Shut-off".

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.2 INSTALLATION, GENERAL REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.
- D. Locate identifying devices so that they are readily visible from the point of normal approach.

3.3 INSTALLATION OF EQUIPMENT LABELS, WARNING SIGNS, AND LABELS

- A. Permanently fasten labels on each item of plumbing equipment.
- B. Sign and Label Colors.
 1. White letters on an ANSI Z535.1 safety-green background.
- C. Locate equipment labels where accessible and visible.
- D. Provide nameplates for equipment with identifying name of equipment and function.
- E. Provide name plates for panels identifying name of panel and function, function of switches, control devices, panel lights, and buttons and securely fasten to panels.

- F. Locate warning signs for high efficiency water heater vents run horizontally through an exterior wall at a minimum of 8 feet above finished grade.
- G. Arc-Flash Warning Signs: Provide arc-flash warning signs on electrical disconnects and other equipment where arc-flash hazard exists, as indicated on Drawings, and in accordance with requirements of OSHA and NFPA 70E, and other applicable codes and standards.

3.4 INSTALLATION OF PIPE LABELS

- A. Piping Color Coding: Painting of piping is specified in Section 09 96 00 "High-Performance Coatings."
- B. Install pipe labels showing service and flow direction with permanent adhesive on pipes.
- C. Stenciled Pipe Label Option: Stenciled labels showing service and flow direction may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1 on each piping system.
 - 1. Identification Paint: Use for contrasting background.
 - 2. Stencil Paint: Use for pipe marking.
- D. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Within 3 ft. of each valve and control device.
 - 2. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 3. Within 3 ft. of equipment items and other points of origination and termination.
 - 4. Spaced at maximum intervals of 25 ft. along each run. Reduce intervals to 10 ft. in areas of congested piping and equipment.
- E. Do not apply plastic pipe labels or plastic tapes directly to bare pipes conveying fluids at temperatures of 125 deg F or higher. Where these pipes are to remain uninsulated, use a short section of insulation or use stenciled labels.
- F. Flow-Direction Flow Arrows: Use arrows, in compliance with ASME A13.1, to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- G. Pipe-Label Color Schedule:
 - 1. Low-Pressure Compressed-Air Piping: White letters on an ANSI Z535.1 safety-blue background.
 - 2. Domestic Cold-Water Piping: Black letters on an ANSI Z535.1 safety-green background.
 - 3. Domestic Hot-Water Piping: Black letters on an ANSI Z535.1 safety-green background.
 - 4. Domestic Hot-Water Return Piping: Black letters on an ANSI Z535.1 safety-green background.
 - 5. Sanitary Waste and Storm Drainage Piping: Black letters on an ANSI Z535.1 safety-green background.

- H. Trap Primer Water Piping: Provide Piping Identification Labels on exposed water piping between trap primers and drain connections exceeding 10 feet in length at 5 foot intervals. Text to read “Non-potable Water”.

3.5 INSTALLATION OF VALVE TAGS

- A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule in the operating and maintenance manual.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
 - 1. Valve-Tag Color: Natural.
 - 2. Letter Color: Black.
- C. Provide valve tag for each piping systems valve located above grade.
 - 1. Valve Directory: Provide neat typewritten directory listing valve function, location and identification number.
 - 2. Valve Numbering System: Extension of and compatible with existing valve numbering system, where valves are installed in existing building or in addition to existing building.
 - 3. Verification: Verify existing valve numbers in field and provide valve numbering avoiding duplication of existing numbers.

END OF SECTION 22 05 53

SECTION 22 07 19 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes insulating the following plumbing piping services:
 - 1. Domestic cold-water piping.
 - 2. Domestic hot-water piping.
 - 3. Domestic recirculating hot-water piping.
 - 4. Roof drains and rainwater leaders.
 - 5. Supplies and drains for handicap-accessible lavatories and sinks.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).
 - 1. Flexible elastomeric insulation.
 - 2. Mineral-fiber, preformed pipe insulation.
 - 3. Spray polyurethane foam.
 - 4. Mineral-fiber, hydraulic-setting insulating and finishing cement.
 - 5. Vapor-barrier mastic.
 - 6. Woven glass-fiber fabric.
 - 7. Field applied jackets.
 - 8. Protective shielding piping enclosures.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Provide insulation system installation by qualified Installers who are trained in installation of each proposed insulation material and product with at least one of the following qualifications:
 - 1. Have successfully completed a Mechanical Insulation Apprenticeship program by the Department of Labor, Bureau of Apprenticeship and Training,

2. Have successfully completed an ASHRAE / NIA 8-hour Mechanical Insulation Training course or equal, or,
 3. Have five years documented experience as a mechanical insulation specialist with references attesting to successful completion of at least three comparable projects.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
- C. Comply with the following applicable standards and other requirements specified for miscellaneous components:
1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.8 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Aeroflex USA, Inc.; Aerocel.
 - b. Armacell LLC; AP Armaflex.
 - c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.
- G. Mineral-Fiber, Preformed Pipe Insulation:
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Fibrex Insulations Inc.; Coreplus 1200.
 - b. Johns Manville; Micro-Lok.
 - c. Knauf Insulation; 1000-Degree Pipe Insulation.
 - d. Manson Insulation Inc.; Alley-K.
 - e. Owens Corning; Fiberglas Pipe Insulation.
 - 2. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- H. Glass-Fiber Loose-Fill Insulation: Comply with requirements for glass-fiber loose-fill insulation specified in Section 07 21 00 "Thermal Insulation."
- I. Spray polyurethane foam: Comply with requirements for spray polyurethane foam specified in Section 07 21 00 "Thermal Insulation."

2.2 INSULATING CEMENTS

- A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Aeroflex USA, Inc.; Aeroseal.
 - b. Armacell LLC; Armaflex 520 Adhesive.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
 - d. K-Flex USA; R-373 Contact Adhesive.
 - 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
 - b. Eagle Bridges - Marathon Industries; 225.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
 - d. Mon-Eco Industries, Inc.; 22-25.
 - 2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. PVC Jacket Adhesive: Compatible with PVC jacket.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Dow Corning Corporation; 739, Dow Silicone.
 - b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.

- c. P.I.C. Plastics, Inc.; Welding Adhesive.
- d. Speedline Corporation; Polyco VP Adhesive.

2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
- B. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-30.
 - b. Eagle Bridges - Marathon Industries; 501.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-35.
 - d. Mon-Eco Industries, Inc.; 55-10.
 - 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
 - 3. Service Temperature Range: 0 to 180 deg F.
 - 4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
 - 5. Color: White.

2.5 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.
 - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
 - c. Vimasco Corporation; 713 and 714.
 - 2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
 - 3. Service Temperature Range: 0 to plus 180 deg F.
 - 4. Color: White.

2.6 SEALANTS

A. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ-SSL: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing, self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

2.8 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Johns Manville; Zeston.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto Corporation; LoSmoke.
 - d. Speedline Corporation; SmokeSafe.
2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.

4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and roof drain bodies.

2.9 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ABI, Ideal Tape Division; 428 AWF ASJ.
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
 - c. Compac Corporation; 104 and 105.
 - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ABI, Ideal Tape Division; 370 White PVC tape.
 - b. Compac Corporation; 130.
 - c. Venture Tape; 1506 CW NS.
2. Width: 2 inches.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

2.10 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ITW Insulation Systems; Gerrard Strapping and Seals.
 - b. RPR Products, Inc.; Insul-Mate Strapping and Seals.
2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 316; 0.015 inch thick, 1/2 inch wide with wing seal.

B. Wire: 0.062-inch soft-annealed, stainless steel.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. C & F Wire.

2.11 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Piping Enclosures:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Truebro; a brand of IPS Corporation.
 - b. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.
2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 1. Verify that systems to be insulated have been tested and are free of defects.
 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 3. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.

2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive along both edges of strip.
 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap.
 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere and seal patches similar to butt joints.
- P. For above-ambient services, do not install insulation to the following:
1. Testing agency labels and stamps.
 2. Nameplates and data plates.
 3. Cleanouts.
- Q. Miscellaneous Voids: Install insulation where indicated and in miscellaneous openings and penetrations in the exterior building envelope, including pipe sleeves, exterior wall hydrants, roof drains, downspout nozzles, pipe chases located on exterior walls, voids and cavity spaces created by Plumbing Work where required to provide continuity and integrity to the building exterior envelope insulation system, sealing gaps and preventing air infiltration, using the following materials:
1. Loose-Fill Insulation: Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft.
 2. Spray Polyurethane Foam: Apply according to manufacturer's written instructions.
 - a. Trim and dress surface of spray polyurethane foam to provide smooth, flush surface.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 4. Seal jacket to wall flashing with flashing sealant.
- C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
1. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
- E. Insulation Installation at Floor Penetrations:
1. Pipe: Install insulation continuously through floor penetrations.
 2. Seal penetrations through fire-rated assemblies.
 3. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
8. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulation Installation on Roof Drain Bodies:

1. Insulate roof drain bodies using preformed fitting insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement.
2. Adhere fitted PVC cover to insulated Roof Drain Body with PVC Jacket Adhesive. Tape PVC covers to adjoining insulation facing using PVC tape. Seal voids to maintain vapor barrier on drain body assembly.

D. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

E. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
 1. Install pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
 4. Secure insulation to flanges and seal seams with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
 1. Install mitered sections of pipe insulation.
 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
 1. Install preformed valve covers manufactured of same material as pipe insulation when available.
 2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. Secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.8 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
 - 1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
 - 2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
 - 3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where FSK jackets are indicated, install as follows:
 - 1. Draw jacket material smooth and tight.
 - 2. Install lap or joint strips with same material as jacket.
 - 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 - 4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
 - 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.
 - 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.9 FINISHES

- A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 09 91 00 "Painting".
 - 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

3.10 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - 1. Drainage piping located in crawl spaces.
 - 2. Underground piping.
 - 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.11 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Cold Water (General Building Areas):
 - 1. Mineral-Fiber, Preformed Pipe Insulation with factory applied jacket, Type I: 1-inch thickness.
- B. Domestic Cold Water located within Masonry Block Wall cores, horizontal runs in metal stud walls or buried conduits:
 - 1. Flexible Elastomeric Insulation: 1/2-inch thick.
- C. Domestic Hot and Recirculation Water (General Building Areas):
 - 1. Mineral-Fiber, Preformed Pipe Insulation with factory applied jacket, Type I:
 - a. Pipes size 1 1/4" or smaller: 1-inch thickness.
 - b. Pipes size 1 1/2" or larger: 1-1/2-inch thickness.
- D. Domestic Hot and Recirculation Water located within Masonry Block Wall cores, horizontal runs in metal stud walls or buried conduits:
 - 1. Flexible Elastomeric Insulation:
 - a. Pipes size 1 1/4" or smaller: 1/2-inch thickness.
 - b. Pipes size 1 1/2" or larger: 1-inch thickness.
- E. Freezer Condensate Piping:
 - 1. Flexible Elastomeric Insulation: 1/2-inch thick.
- F. Stormwater and Overflow:
 - 1. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-inch thick.
- G. Roof Drain and Overflow Drain Bodies:
 - 1. Mineral-Fiber, Preformed Pipe Insulation without factory applied jacket, Type I: 2-inch thick.

- H. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:

- 1. Protective Shielding Pipe Covers.

3.12 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. Piping, Exposed:
 - 1. PVC: 30 mils thick.

END OF SECTION 22 07 19

SECTION 22 11 13 - FACILITY WATER DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes water-distribution piping and related components outside the building for fire-hydrants, piping, valves and other appurtenances.

1.3 DEFINITIONS

- A. EPDM: Ethylene propylene diene terpolymer rubber.
- B. LLDPE: Linear, low-density polyethylene plastic.
- C. PA: Polyamide (nylon) plastic.
- D. PE: Polyethylene plastic.
- E. PP: Polypropylene plastic.
- F. PVC: Polyvinyl chloride plastic.
- G. RTRF: Reinforced thermosetting resin (fiberglass) fittings.
- H. RTRP: Reinforced thermosetting resin (fiberglass) pipe.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. Piping and fittings
 - 2. Gate valves and curb boxes
 - 3. Fire hydrants
 - 4. Identification materials
 - 5. Miscellaneous components and accessories

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: For piping and specialties including relation to other services in same area, drawn to scale. Show piping and specialty sizes and valves, meter and specialty locations, and elevations.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For water valves and specialties to include in emergency, operation, and maintenance manuals.

- B. Field quality-control test reports.
- C. As-Built Pressure / Flow Test Results

1.7 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.
2. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.
3. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.
4. Backflow Preventers: Provide devices complying with applicable provisions of Section 5-1.31 of the New York State Sanitary Code and listed as approved by current edition of the List of Approved Backflow Prevention Assemblies generated by the University of Southern California Foundation for Cross- Connection Control and Hydraulic Research (FCCCHR).

B. Piping materials shall bear label, stamp, or other markings of specified testing agency.

C. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.

D. NSF Compliance:

1. Comply with NSF 14 for plastic potable-water-service piping. Include marking "NSF-pw" on piping.
2. Comply with NSF 61 Annex G for materials for water-service piping and specialties for domestic water.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Transport: Prepare valves, including fire hydrants, according to the following:

1. Ensure that valves are dry and internally protected against rust and corrosion.
2. Protect valves against damage to threaded ends and flange faces.
3. Set valves in best position for handling. Set valves closed to prevent rattling.

B. During Storage: Use precautions for valves, including fire hydrants, according to the following:

1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
2. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.

- C. Handling: Use sling to handle valves and fire hydrants if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.
- D. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.
- E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.
- F. Protect flanges, fittings, and specialties from moisture and dirt.
- G. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.9 PROJECT CONDITIONS

- A. Interruption of Existing Water-Distribution Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water-distribution service according to requirements indicated:
 - 1. Notify Architect and Owner no fewer than two 2 days in advance of proposed interruption of service.
 - 2. Do not proceed with interruption of water-distribution service without Architect's and Owner's written permission.

1.10 COORDINATION

- A. Coordinate connection to water main with utility company.

PART 2 - PRODUCTS

2.1 DUCTILE-IRON PIPE AND FITTINGS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Clow Water Systems Co.
 - 2. Griffin Pipe Products Co.
 - 3. U.S Pipe and Foundry Company.
- B. Mechanical-Joint, Ductile-Iron Pipe: ANSI/AWWA C151/A21.5 centrifugally cast with mechanical-joint bell and plain spigot end, Thickness Class 52, double cement lined, bituminous coated.
 - 1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile-iron standard pattern or AWWA C153, ductile-iron compact pattern, Class 350.

2. Glands, Gaskets, and Bolts: AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
- C. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end, Thickness Class 52, double cement lined, bituminous coated.
 1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 2. Gaskets: AWWA C111, rubber.
- D. Flanges: ASME 16.1, Class 125, cast iron.
- E. Cement-Mortar Lining in accordance with ANSI/AWWA C104/A21.4.
- F. Asphaltic coating in accordance with ANSI/AWWA C151/A21.5.

2.2 PIPING SPECIALTIES

- A. Transition Fittings: Install transition couplings at joints of piping with small differences in OD's.
- B. Dielectric Fittings: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

2.3 GATE VALVES

- A. AWWA, Cast-Iron Gate Valves:
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Clow Valve Company; a subsidiary of McWane, Inc.
 - b. Kennedy Valve Company; a division of McWane, Inc.
 - c. Mueller Co.
 2. Nonrising-Stem, Resilient-Seated Gate Valves:
 - a. Description: Gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut.
 - 1) Standard: AWWA C509.
 - 2) Minimum Pressure Rating: 200 psig
 - 3) End Connections: Mechanical joint.
 - 4) Interior Coating: Complying with AWWA C550.

2.4 GATE VALVE ACCESSORIES AND SPECIALTIES

A. Tapping-Sleeve Assemblies:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Clow Valve Company; a subsidiary of McWane, Inc.
 - b. Kennedy Valve Company; a division of McWane, Inc.
 - c. Mueller Co.
2. Description: Sleeve and valve compatible with drilling machine.
 - a. Standard: MSS SP-60.
 - b. Tapping Sleeve: Cast- or ductile-iron or stainless-steel, two-piece bolted sleeve with flanged outlet for new branch connection. Include sleeve matching size and type of pipe material being tapped and with recessed flange for branch valve.
 - c. Valve: AWWA, cast-iron, nonrising-stem, [resilient-seated gate valve with one raised face flange mating tapping-sleeve flange.

B. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel approximately 5 inches in diameter.

1. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.

2.5 FIRE HYDRANTS

A. Dry-Barrel Fire Hydrants:

1. Description: Freestanding, with one NPS 4-1/2 and two NPS 2-1/2 outlets, 5-1/4-inch main valve, drain valve, and NPS 6 mechanical-joint inlet. Include interior coating according to AWWA C550. Hydrant shall have cast-iron body, compression-type valve opening against pressure and closing with pressure.
 - a. Standard: AWWA C502.
 - b. Pressure Rating: 250 psig.

PART 3 - EXECUTION

3.1 EARTHWORK

- #### A.
- Refer to Section 31 20 00 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- A. General: Use pipe, fittings, and joining methods for piping systems according to the following applications.
- B. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.
- C. Do not use flanges or unions for underground piping.
- D. Flanges, unions, grooved-end-pipe couplings, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.
- E. Underground Combined Water-Service and Fire-Service-Main Piping 6-inch to 8-inch diameter shall be the following:
 - 1. Ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed joints.

3.3 VALVE APPLICATIONS

- A. General Application: Use mechanical-joint-end valves for four-inch and larger underground installation.
- B. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Underground Valves, four-inch and Larger: AWWA, cast-iron, nonrising-stem, resilient seated gate valves with valve box.

3.4 PIPING INSTALLATION

- A. Water-Main Connection: Tap water main according to requirements of water utility company and of size and in location indicated.
- B. Make connections larger than four-inch with tapping machine according to the following:
 - 1. Install tapping sleeve and tapping valve according to MSS SP-60.
 - 2. Install tapping sleeve on pipe to be tapped. Position flanged outlet for gate valve.
 - 3. Use tapping machine compatible with valve and tapping sleeve; cut hole in main. Remove tapping machine and connect water-service piping.
 - 4. Install gate valve onto tapping sleeve. Comply with MSS SP-60. Install valve with stem pointing up and with valve box.
- C. Comply with NFPA 24 for fire-service-main piping materials and installation.
- D. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.
- E. Bury piping with depth of cover over top at least five feet.

3.5 JOINT CONSTRUCTION

- A. Make pipe joints according to the following:
 - 1. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.
 - 2. Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194.
 - 3. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
 - a. Dielectric Fittings for 4 inch and Larger: Use dielectric flange kits.

3.6 ANCHORAGE INSTALLATION

- A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:
 - 1. Concrete thrust blocks.
 - 2. Locking mechanical joints.
 - 3. Set-screw mechanical retainer glands.
 - 4. Bolted flanged joints.
 - 5. Pipe clamps and tie rods.
- B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:
 - 1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.
 - 2. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.
 - 3. Bonded-Joint Fiberglass, Water-Service Piping: According to AWWA M45.
 - 4. Fire-Service-Main Piping: According to NFPA 24.
- C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.7 VALVE INSTALLATION

- A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.
- B. AWWA Valves Other Than Gate Valves: Comply with AWWA C600 and AWWA M44.

3.8 FIRE HYDRANT INSTALLATION

- A. General: Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position.
- B. AWWA Fire Hydrants: Comply with AWWA M17.
- C. UL/FMG Fire Hydrants: Comply with NFPA 24.

3.9 FIELD QUALITY CONTROL

- A. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.
- B. Hydrostatic Tests: Test at not less than one-and-one-half times working pressure for two hours.
 - 1. Increase pressure in 50-psig increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 psig. Slowly increase again to test pressure and hold for 1 more hour. Maximum allowable leakage is 2 quarts per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.
- C. Prepare reports of testing activities.

3.10 IDENTIFICATION

- A. Install continuous underground detectable warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Section 312000 "Earth Moving."

3.11 CLEANING

- A. Clean and disinfect water-distribution piping as follows:
 - 1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
 - 2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:
 - a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.
 - b. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for 3 hours.
 - c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
 - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.
- B. Prepare reports of purging and disinfecting activities.

END OF SECTION 22 11 13

SECTION 22 11 16 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Copper tube and fittings.
 - 2. Piping joining materials.
 - 3. Transition fittings.
 - 4. Dielectric fittings.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Pipe and tube.
 - 2. Fittings.
 - 3. Joining materials.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Piping layout, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.
- B. System purging and disinfecting activities report.
- C. Lab results for lead testing upon completion of work.

1.5 CLOSEOUT SUBMITTALS

- A. Field quality-control reports.
- B. Lab results for biological testing showing samples negative for coliform bacteria.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Installers of pressure-sealed joints are to be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

1.7 FIELD CONDITIONS

- A. Interruption of Existing Water Service: Refer to “Existing Utility Interruptions” paragraph of Section 01 12 00 “Multiple Contract Summary-Project Schedule” for requirements associated with interrupting the existing water service to facilities occupied by the Owner.
- B. Refer to the “Project/Site Conditions” article for lead testing requirements prior to commencing any work in Section 22 05 00 “Common Work Results for Plumbing.”
- C. Coordinate potable water lead testing with Owner prior to starting any construction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Domestic water piping, tubing, fittings, joints, and appurtenances intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act, with requirements of authorities having jurisdiction, and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 PIPING MATERIALS

- A. Potable-water piping and components are to comply with NSF 14, NSF 61, and NSF 372.

2.3 COPPER TUBE AND FITTINGS - DOMESTIC WATER

- A. Drawn-Temper Copper Tube: ASTM B88, Type L.
- B. Annealed-Temper Copper Tube: ASTM B88, Type L.
- C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings. Do not use solder joints on pipe sizes greater than NPS 4.
- D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings. Do not use solder joints on pipe sizes greater than NPS 4.
- E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Do not use solder joints on pipe sizes greater than NPS 4.
- F. Cast Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends. Do not use solder joints on pipe sizes greater than NPS 4.
- G. Wrought Copper Unions: ASME B16.22. Do not use solder joints on pipe sizes greater than NPS 4.

H. Pressure-Seal-Joint Fittings, Copper or Bronze - Domestic Water:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. Elkhart Brass Mfg. Co., Inc.
 - c. FNW; Ferguson Enterprises, Inc.
 - d. Mueller Streamline Co.; a company of Mueller Industries.
 - e. NIBCO INC.
 - f. Viega LLC.
2. Source Limitations: Obtain pressure-seal-joint fittings, copper or bronze, from single manufacturer.
3. Housing: Copper.
4. O-Rings and Pipe Stops: EPDM.
5. Tools: Manufacturer's special tools.
6. Minimum 200 psig working-pressure rating at 250 deg F.

2.4 PIPING JOINING MATERIALS - DOMESTIC WATER

A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B32, lead-free alloys.

D. Flux: ASTM B813, water flushable.

E. Brazing Filler Metals: AWS A5.8M/A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.5 TRANSITION FITTINGS - DOMESTIC WATER

- A. Install transition couplings at joints of piping with small differences in OD's. Refer to transition fitting products specified in Section 22 05 00 "Common Work Results for Plumbing".

2.6 DIELECTRIC FITTINGS - DOMESTIC WATER

- A. Dielectric Unions and Flanges: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined. Comply with requirements in Section 22 05 00 "Common Work Results for Plumbing."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Refer to the "PROJECT/SITE CONDITIONS" article for lead testing requirements prior to commencing any work in Section 22 05 00 "Common Work Results for Plumbing."
- B. Before proceeding with water piping installation, examine conditions existing at Site and notify affected Contractors and Architect of any construction or any other conditions prevailing which prevent, inhibit, or otherwise interfere with water piping installation.
- C. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 PIPING APPLICATIONS

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Aboveground domestic water piping, NPS 4 or smaller is to be one of the following:
 - 1. Drawn-temper copper tube, ASTM B88, Type L; cast or wrought-copper, solder-joint fittings; and soldered joints.
 - 2. Drawn-temper copper tube, ASTM B88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.

3.3 INSTALLATION OF PIPING

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install copper tubing under building slab in accordance with CDA's "Copper Tube Handbook."
- C. Install valves in accordance with Section 22 05 23 "General Duty Valves for Plumbing Piping."
- D. Install domestic water piping level without pitch and plumb.
- E. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

- F. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- G. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
- H. Install piping to permit valve servicing.
- I. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
- J. Install piping free of sags and bends.
- K. Install fittings for changes in direction and branch connections.
- L. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- M. Install pressure gauges on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gauges in Section 22 05 19 "Meters and Gauges for Plumbing Piping."
- N. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 22 11 23.21 "Inline, Domestic Water Pumps."
- O. Install thermometers on outlet piping from each water heater. Comply with requirements for thermometers in Section 22 05 19 "Meters and Gauges for Plumbing Piping."
- P. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."
- Q. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."
- R. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

3.4 PROTECTION

- A. Thermal expansion and contraction: Wrap copper and copper alloy tube passing through a wall, floor, ceiling or partition with tape or pipe insulation. Install tube through an appropriately sized sleeve to allow for thermal movement.
- B. Protect against abrasion where copper and copper alloy tube contacts building materials. Wrap tube with tape, pipe insulation, metal stud insulating pipe clamps or suitable method of isolation.

3.5 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.
- E. Soldered Joints for Copper Tubing: Apply ASTM B813, water-flushable flux to end of tube. Join copper tube and fittings in accordance with ASTM B828 or CDA's "Copper Tube Handbook."
- F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools and procedure recommended by pressure-seal-fitting manufacturer. Leave insertion marks on pipe after assembly.
- G. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts in accordance with ASME B31.9.
- H. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.6 INSTALLATION OF TRANSITION FITTINGS

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

3.7 INSTALLATION OF DIELECTRIC FITTINGS

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

3.8 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements for hangers, supports, and anchor devices in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."
- B. Install hangers for copper pipe, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

- C. Support horizontal piping within 12 inches of each fitting.
- D. Support vertical runs of copper pipe to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.9 PIPING CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
 - 1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
 - 2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
 - 3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
 - 4. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.10 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.11 CLEANING

- A. Clean and disinfect potable domestic water piping as follows:
 - 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 - 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.

- b. Fill and isolate system in accordance with either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Repeat procedures if biological examination shows contamination.
 - e. Submit water samples in sterile bottles to authorities having jurisdiction.
- B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.
- C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.12 ADJUSTING

- A. Perform the following adjustments before operation:
- 1. Close drain valves, hydrants, and hose bibbs.
 - 2. Open shutoff valves to fully open position.
 - 3. Open throttling valves to proper setting.
 - 4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
 - b. Adjust calibrated balancing valves to flows indicated.
 - 5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
 - 6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
 - 7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
 - 8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.13 FIELD QUALITY CONTROL

A. Perform the following tests:

1. Comply with "Field Quality Control" article in Part 3 of Section 22 05 00 "Common Work Results for Plumbing" for lead testing requirements prior to commencing any work.
2. Piping Inspections:
 - a. Do not enclose, cover, or put piping into operation until it has been tested and inspected by the Owner's Representative.
 - b. During installation, notify Owner's Representative at least two days before inspection must be made. Perform tests specified below in presence of Owner's Representative:
 - 1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
 - 2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
 - c. Reinspection: If Owner's Representative finds that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
 - d. Reports: Prepare inspection reports and have them signed by the Owner's Representative.
3. Above Grade Piping Tests:
 - a. Initial Test:
 - 1) Do not connect fixtures, equipment, and solenoid valves into system during this test.
 - 2) Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - 3) Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
 - 4) Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 5) Cap and subject piping to static water pressure of 150 psi, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

- 6) Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
 - 7) Prepare reports for tests and for corrective action required.
- b. Test After Fixtures are Connected:
- 1) Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - 2) Test system again for 2 hours at 75 psi or prevailing water pressure, whichever is higher.
 - 3) Repair leaks and defects at fixture and equipment connections or at solenoid valves, and retest piping or portion thereof until satisfactory results are obtained.
 - 4) Prepare reports for tests and for corrective action required.
- B. Domestic water piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

END OF SECTION 22 11 16

SECTION 22 11 19 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Vacuum breakers.
2. Backflow preventers.
3. Balancing valves.
4. Temperature-actuated, water mixing valves.
5. Strainers for domestic water piping.
6. Outlet boxes.
7. Hose bibbs.
8. Wall hydrants.
9. Drain valves.
10. Water-hammer arresters.
11. Air vents.
12. Trap-seal primer valves.

- B. Regulatory Requirements:

1. Backflow Preventers: Provide devices complying with applicable provisions of Section 5-1.31 of the New York State Sanitary Code and listed as approved by current edition of the List of Approved Backflow Prevention Assemblies generated by the University of Southern California Foundation for Cross- Connection Control and Hydraulic Research (FCCCHR).

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for domestic water piping specialties. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1. Spill-resistant vacuum breakers.
2. Reduced-pressure-principle backflow preventers.
3. Calibrated balancing valves.
4. Primary, thermostatic, water mixing valves.
5. Individual-fixture, water tempering valves.
6. Nonfreeze wall hydrants.

7. Moderate-climate wall hydrants.
8. Stop-and-waste drain valves.
9. Water hammer arresters.
10. Trap-seal primer device.

B. As-Specified Data: If the product to be incorporated in the Work is as specified by manufacturer name and product designation in this Specification Section, submit the “**As-Specified Verification Form**” (attached to Section 01 33 00 “Submittal Procedures”) for each item listed below; otherwise submit full Product Data for the following:

1. Pressure vacuum breakers.
2. Clothes washer outlet boxes.
3. Hose bibbs.
4. Hose-end drain valves.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.
- B. Test and inspection reports.
- C. Field quality-control reports.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

- A. Domestic water piping specialties intended to convey or dispense water for human consumption are to comply with the SDWA, requirements of authorities having jurisdiction, and NSF 61 and NSF 372, or to be certified in compliance with NSF 61 and NSF 372 by an American National Standards Institute (ANSI)-accredited third-party certification body that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.3 VACUUM BREAKERS

- A. Pressure Vacuum Breakers NPS 2 and Smaller:
 1. Basis-of-Design Product: Subject to compliance with requirements, provide WATTS ; LF800. or a comparable product by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. FEBCO; A WATTS Brand.
 - c. Zurn Industries, LLC.

2. Standard: ASSE 1020.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 5 psig maximum, through middle third of flow range.
5. Accessories: Valves: Ball type, on inlet and outlet.
6. Refer to schedule on Drawings for flow and pressure characteristics.

2.4 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers NPS 2 and Smaller:

1. Basis-of-Design Product: Subject to compliance with requirements, provide WATTS; LF009 or a comparable product by one of the following:
 - a. Ames Fire & Waterworks; A WATTS Brand.
 - b. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - c. FEBCO; A WATTS Brand.
 - d. Zurn Industries, LLC.
2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Body: Lead free cast bronze.
5. End Connections: Threaded.
6. Configuration: Designed for horizontal, straight-through flow.
7. Accessories:
 - a. Valves: Ball type with threaded ends on inlet and outlet.
 - b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.
8. Capacities and Characteristics: Refer to Schedules on Drawings.

2.5 BALANCING VALVES

A. Lead Free Copper-Alloy Calibrated Balancing Valves:

1. Basis-of-Design Product: Subject to compliance with requirements, provide NIBCO INC.; T/S-1810-LF. or a comparable product by one of the following:
 - a. Bell & Gossett; a Xylem brand.
 - b. IMI Hydronic Engineering Inc.
 - c. Nexus Valve, Inc.
 - d. WATTS.

2. Type: Y-pattern globe valve with two readout ports and memory-setting indicator.
3. Body: Brass or bronze.
4. Size: Same as connected piping, but not larger than NPS 2.
5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

B. Automatic Flow Control Balancing Valves:

1. Basis-of-Design Product: Subject to compliance with requirements, provide ThermOmegaTech; CircuitSolver or a comparable product by one of the following:
 - a. Caleffi North America.
 - b. IMI Hydronic Engineering Inc.
2. Flow Regulation: Plus or minus 5 percent over 95 percent of the working range.
3. Pressure Rating: 200 psig.
4. Size: NPS 2 or smaller.
5. Body: Stainless steel or brass.
6. Flow Cartridge: Stainless steel or antiscaling polymer.
7. End Connections: Threaded or solder joint.

2.6 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Water-Temperature Limiting Devices (TMV-1):

1. Basis-of-Design Product: Subject to compliance with requirements, provide POWERS; A WATTS Brand; Model LFUSG-B-M2 or comparable product by one of the following:
 - a. Cash Acme; a division of Reliance Worldwide Corporation; Heatguard 145 LF.
 - b. Lawler Manufacturing Co. Inc.; Model 570.
 - c. Leonard Valve Company; 170A-LF with mounting bracket.
 - d. Watts; a Watts Water Technologies Company; Model LFUSG-B
 - e. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products; 38-ZW3870XLT.
2. Standard: ASSE 1070.
3. Pressure Rating: 125 psig.
4. Type: Thermostatically controlled, water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded inlets and outlet.

7. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Valve Finish: Rough bronze.
9. Capacities and Characteristics: Refer to Schedules on Drawings.

B. Primary, Thermostatic, Water Mixing Valves (TMV-2):

1. Basis-of-Design Product: Subject to compliance with requirements, provide POWERS; A WATTS Brand; Model LFMM433 or comparable product by one of the following:
 - a. Lawler Manufacturing Company, Inc.; Series 66.
 - b. Leonard Valve Company; ECO-MIX series.
 - c. Watts; a Watts Water Technologies Company; LFN170 series.
2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig minimum unless otherwise indicated.
4. Type: Exposed-mounted, thermostatically controlled, water mixing valve.
5. Material: Lead free bronze body with corrosion-resistant interior components.
6. Connections: Threaded union inlets and outlet.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Valve Finish: Rough bronze.
9. Piping Finish: Copper.
10. Capacities and Characteristics: Refer to Schedules on Drawings.

2.7 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Basis-of-Design Product: Subject to compliance with requirements, provide NIBCO Inc; Model T-222-A or F-721-A or comparable product by one of the following:
 - a. Conbraco Industries, Inc.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Jenkins Valves.
 - d. Crane Co.; Crane Valve Group; Stockham Div.
 - e. Hammond Valve.
 - f. Milwaukee Valve Company.
 - g. Watts; a Watts Water Technologies Company.
 - h. Zurn Industries, LLC.

2. Pressure Rating: 125 psig minimum unless otherwise indicated.
3. Body: Bronze for NPS 2 and smaller.
4. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
5. Screen: Stainless steel with round perforations unless otherwise indicated.
6. Perforation Size:
 - a. Strainers NPS 2 and Smaller: 0.020 inch.
7. Drain: Pipe plug.

2.8 OUTLET BOXES

A. Clothes Washer Outlet Boxes:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Guy Gray, IPS Corporation; Model T200QT or comparable product by one of the following:
 - a. Acorn Engineering Company; a Division of Morris Group International.
 - b. LSP Products Group.
 - c. Oatey.
 - d. Sioux Chief Manufacturing Company, Inc.
 - e. Water-Tite, IPS Corporation.
 - f. Watts; a Watts Water Technologies Company; Model 2M2 DWB.
2. Mounting: Recessed.
3. Material and Finish: Enameled-steel or epoxy-painted-steel box and faceplate.
4. Faucet: Combination valved fitting or separate hot- and cold-water valved fittings complying with ASME A112.18.1. Include garden-hose thread complying with ASME B1.20.7 on outlets.
5. Supply Shutoff Fittings: NPS 1/2 ball valves and NPS 1/2 copper, water tubing.
6. Drain: NPS 2 standpipe and P-trap for direct waste connection to drainage piping.

B. Icemaker Outlet Boxes:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Guy Gray, IPS Corporation; Model MIB1AB or comparable product by one of the following:
 - a. LSP Products Group.
 - b. Oatey.
 - c. Sioux Chief Manufacturing Company, Inc.
 - d. Water-Tite, IPS Corporation.
2. Mounting: Recessed.

3. Material and Finish: Enameled-steel or epoxy-painted-steel box and faceplate.
4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.
5. Supply Shutoff Fitting: NPS 1/2 ball valve and NPS 1/2 copper, water tubing.

2.9 HOSE BIBBS

A. Hose Bibbs:

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Rough bronze.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Wheel handle.
13. Operation for Finished Rooms: Operating key.
14. Include operating key with each operating-key hose bibb.
15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.10 WALL HYDRANTS

A. Non-freeze Wall Hydrants (EXT WH):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith Mfg Co; a division of Morris Group International; Model No. 5509-QT-NB or comparable product by one of the following:
 - a. Josam Company.
 - b. MIFAB, Inc.
 - c. Prier Products, Inc.
 - d. WATTS.
 - e. Woodford Manufacturing Company.
 - f. Zurn Industries, LLC.
2. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig.
4. Operation: Loose key.

5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
6. Inlet: NPS 3/4 or NPS 1.
7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
8. Box: Recessed stainless steel, flush mounted with cover.
9. Cover Finish: Polished nickel bronze.
10. Operating Keys(s): One with each wall hydrant.

B. Moderate-Climate Wall Hydrants (INT WH):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith Mfg Co; a division of Morris Group International; Model No. 5509-QT-SAP-NB or comparable product by one of the following:
 - a. Josam Company.
 - b. MIFAB, Inc.
 - c. Prier Products, Inc.
 - d. WATTS.
 - e. Woodford Manufacturing Company.
 - f. Zurn Industries, LLC.
2. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig.
4. Operation: Loose key.
5. Inlet: NPS 3/4 or NPS 1.
6. Outlet:
 - a. Concealed, with integral vacuum breaker or nonremovable hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
 - b. Garden-hose thread complying with ASME B1.20.7.
7. Box: Deep, flush mounted with cover.
8. Box and Cover Finish: Polished nickel bronze.
9. Operating Keys(s): Two with each wall hydrant.

2.11 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Basis-of-Design Product: Subject to compliance with requirements, provide NIBCO Inc; Model T-585-70-HC or comparable product by one of the following:
 - a. Conbraco Industries, Inc.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Jenkins Valves.
 - d. Crane Co.; Crane Valve Group; Stockham Div.
 - e. Hammond Valve.
 - f. Milwaukee Valve Company.
 - g. Red-White Valve Corp.
2. Standard: MSS SP-110 for standard-port, two-piece ball valves.
3. Pressure Rating: 400-psig minimum CWP.
4. Size: NPS 3/4.
5. Body: Copper alloy.
6. Ball: Chrome-plated brass.
7. Seats and Seals: Replaceable.
8. Handle: Vinyl-covered steel.
9. Inlet: Threaded or solder joint.
10. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

B. Stop-and-Waste Drain Valves:

1. Basis-of-Design Product: Subject to compliance with requirements, provide NIBCO Inc.; S-FP-600-AD-LF or comparable product by one of the following:
 - a. Conbraco Industries, Inc.
 - b. Hammond Valve.
 - c. Milwaukee Valve Company.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Standard: MSS SP-110 for ball valves.
3. Pressure Rating: 200-psig minimum CWP or Class 125.
4. Size: NPS 3/4.

5. Body: Lead-free copper alloy or ASTM B 62 bronze.
6. Drain: NPS 1/8 side outlet with cap.

2.12 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters (WHA “A” through “F”):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith Mfg Co; a division of Morris Group International; 5200 series “Hydrotrol Junior” or comparable product by one of the following:
 - a. AMTROL, Inc.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. Precision Plumbing Products.
 - e. Sioux Chief Manufacturing Company, Inc.
 - f. WATTS.
 - g. Zurn Industries, LLC.
2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Copper tube with multiple “O” ring pistons.
4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.13 AIR VENTS

A. Bolted-Construction Automatic Air Vents:

1. Body: Bronze.
2. Pressure Rating and Temperature: 125-psig minimum pressure rating at 140 deg F.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 1/2 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

2.14 TRAP-SEAL PRIMER DEVICE

A. Supply-Type, Trap-Seal Primer Device:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Precision Plumbing Products, Inc., Model P1-500 Prime Rite or comparable product by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. MIFAB, Inc.
 - c. Sioux Chief Manufacturing Company, Inc.
 - d. WATTS.

2. Standard: ASSE 1018.
3. Pressure Rating: 125 psig minimum.
4. Body: Bronze.
5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
6. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPING SPECIALTIES

- A. Backflow Preventers: Install in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
 1. Locate backflow preventers in same room as connected equipment or system.
 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
 3. Do not install bypass piping around backflow preventers.
- B. Balancing Valves: Install in locations where they can easily be adjusted. Set at indicated design flow rates.
- C. Temperature-Actuated, Water Mixing Valves: Install with check stops or shutoff valves on inlets and with shutoff valve on outlet.
 1. Install cabinet-type units recessed in or surface mounted on wall as specified.
- D. Y-Pattern Strainers: For water, install on supply side of each pump.
- E. Outlet Boxes: Install boxes recessed in wall or surface mounted on wall. Install 1-1/2-by-3-1/2-inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 06 10 00 "Rough Carpentry."
- F. Water-Hammer Arresters: Install in water piping in accordance with PDI-WH 201.
- G. Supply-Type, Trap-Seal Primer Device: Install with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

3.2 PIPING CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping specialties adjacent to equipment and machines, allow space for service and maintenance.

3.3 IDENTIFICATION

- A. Plastic Labels for Equipment: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. Reduced-pressure-principle backflow preventers.
 - 2. Double-check, detector-assembly backflow preventers.
 - 3. Calibrated balancing valves.
 - 4. Primary, thermostatic, water mixing valves.
 - 5. Outlet boxes.
 - 6. Supply-type, trap-seal primer valves.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment".

3.4 ADJUSTING

- A. Set field-adjustable flow set points of balancing valves.
- B. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.
- C. Adjust each pressure vacuum breaker, reduced-pressure-principle backflow preventer, and double-check, detector-assembly backflow preventer in accordance with manufacturer's written instructions, authorities having jurisdiction and the device's reference standard.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Test each pressure vacuum breaker, reduced-pressure-principle backflow preventer and double-check, detector-assembly backflow preventer according to authorities having jurisdiction and the device's reference standard.
 - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

- B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

END OF SECTION 22 11 19

SECTION 22 11 23.21 - INLINE, DOMESTIC-WATER PUMPS**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. In-line circulating pumps.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include construction materials, rated capacities, certified performance curves with operating points plotted on curves, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 1. Circulation Pump CP-1.
 - 2. Circulation Pump CP-2.
 - 3. Circulation Pump CP-3.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For inline, domestic-water pumps to include in operation and maintenance manuals.
- B. Field quality-control reports.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Retain shipping flange protective covers and protective coatings during storage.
- B. Protect bearings and couplings against damage.
- C. Comply with pump manufacturer's written instructions for handling.

PART 2 - PRODUCTS**2.1 PERFORMANCE REQUIREMENTS**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- B. UL Compliance: UL 778 for motor-operated water pumps.
- C. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF 61 and NSF 372.

2.2 IN-LINE CIRCULATING PUMPS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Armstrong Pumps Inc.
 - 2. Bell & Gossett Domestic Pump; ITT Corporation.
 - 3. Grundfos Pumps Corp.
 - 4. TACO Incorporated.
 - 5. WILO USA LLC - WILO Canada Inc.
- B. Description: Factory-assembled and -tested, in-line, close-coupled, canned-motor, overhung-impeller centrifugal pumps.
- C. Capacities and Characteristics: Refer to Schedules on Drawings.
- D. Pump Construction:
 - 1. Pump and Motor Assembly: Hermetically sealed, replaceable-cartridge type with motor and impeller on common shaft and designed for installation with pump and motor shaft horizontal.
 - 2. Minimum Working Pressure: 125 psig.
 - 3. Maximum Continuous Operating Temperature: 220 deg F.
 - 4. Casing: Bronze or stainless steel, with threaded or companion-flange connections.
 - 5. Impeller: Plastic or stainless steel.
 - 6. Motor: Single speed, unless otherwise indicated.

2.3 CONTROLS

- A. Install thermowells for temperature controls as indicated on the plans and in specification section 22 05 19 "Meters and Gauges for Plumbing Piping".

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of domestic-water-piping system to verify actual locations of connections before pump installation.

- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 PUMP INSTALLATION

- A. Mount pumps in orientation complying with manufacturer's written instructions.
- B. Install continuous-thread hanger rods and vibration isolation of size required to support pump weight.
 - 1. Comply with requirements for hangers and supports specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."
- C. Install thermowells in hot-water return piping.
- D. Install time-delay relays in piping between water heaters and hot-water storage tanks.

3.3 PIPING CONNECTIONS

- A. Comply with requirements for piping specified in Section 22 11 16 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to inline, domestic-water pumps, allow space for service and maintenance.
- C. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.
- D. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping. Comply with requirements for valves specified in Section 22 05 23 "General-Duty Valves for Plumbing Piping" and comply with requirements for strainers specified in Section 22 11 19 "Domestic Water Piping Specialties."
- E. Install pressure gage and snubber at suction of each pump and pressure gage and snubber at discharge of each pump. Install at integral pressure-gageappings where provided or install pressure-gage connectors in suction and discharge piping around pumps. Comply with requirements for pressure gages and snubbers specified in Section 22 05 19 "Meters and Gages for Plumbing Piping."

3.4 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring between temperature controllers and devices.

3.5 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment" for identification of pumps.

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Inline, domestic-water pump will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.7 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Check piping connections for tightness.
 - 3. Clean strainers on suction piping.
 - 4. Set thermostats and timers for automatic starting and stopping operation of pumps.
 - 5. Perform the following startup checks for each pump before starting:
 - a. Verify bearing lubrication.
 - b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
 - c. Verify that pump is rotating in the correct direction.
 - 6. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
 - 7. Start motor.
 - 8. Open discharge valve slowly.

9. Adjust temperature settings on thermostats.

10. Adjust timer settings.

3.8 ADJUSTING

- A. Adjust inline, domestic-water pumps to function smoothly, and lubricate as recommended by manufacturer.
- B. Adjust initial temperature set points.
- C. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

END OF SECTION 22 11 23.21

SECTION 22 13 16 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipe, tube, and fittings.
 - 2. Specialty pipe fittings.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. Hub-and-spigot, cast-iron soil pipe and fittings.
 - 2. Hubless, cast-iron soil pipe and fittings.
 - 3. Heavy-duty, high torque hubless-piping couplings.
 - 4. Stainless steel drainage pipe and fittings.
- B. As-Specified Data: If the product to be incorporated in the Work is as specified by manufacturer name and product designation in this Specification Section, submit the “**As-Specified Verification Form**” (attached to Section 01 33 00 “Submittal Procedures”) for each item listed below; otherwise submit full Product Data for the following:
 - 1. CISPI, low torque hubless-piping couplings.
 - 2. Copper pipe and fittings.
 - 3. PVC pipe and fittings for Radon.
 - 4. Transition couplings.

1.4 CLOSEOUT SUBMITTALS

- A. Field quality-control reports.
- B. Coordination Drawings: Plans and elevations, or Building Information Model (BIM) drawn to scale, showing items described in this Section and coordinated with all building trades.

1.5 FIELD CONDITIONS

- A. Interruption of Existing Sanitary Waste Service: Refer to “Existing Utility Interruptions” paragraph of Section 01 12 00 “Multiple Contract Summary-Project Schedule” for requirements associated with interrupting the existing sanitary sewer service to facilities occupied by the Owner.
- B. WARRANTY
- C. Listed manufacturers to provide labeling and warranty of their respective products.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Components and installation are capable of withstanding the following minimum working pressure unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10 ft. head of water.
 - 2. Waste, Force-Main Piping: 100 psig.

2.2 PIPING MATERIALS

- A. Piping materials to bear label, stamp, or other markings of specified testing agency.
- B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AB & I Foundry; a part of the McWane family of companies.
 - 2. Charlotte Pipe and Foundry Company.
 - 3. Tyler Pipe; a part of McWane family of companies.
- B. Pipe and Fittings: Centrifugally cast gray cast iron pipe and static cast fittings conforming to requirements of ASTM Standard A 74, service weight (SV) type. Pipe and fittings marked with the collective trademark of the Cast Iron Soil Institute and listed by NSF® International.
- C. Gaskets: ASTM C564, rubber.

2.4 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AB & I Foundry; a part of the McWane family of companies.
 - 2. Charlotte Pipe and Foundry Company.
 - 3. Tyler Pipe; a part of McWane family of companies.
- B. Pipe and Fittings: Centrifugally cast gray cast iron pipe and static cast fittings conforming to requirements of ASTM A 888 or CISPI 301. Pipe and fittings marked with the collective trademark of the Cast Iron Soil Institute and listed by NSF® International.
- C. CISPI, Hubless-Piping Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ANACO.
 - b. Ideal Tridon Group.
 - c. Mission Rubber Company, LLC; a division of MCP Industries.
 - d. Tyler Pipe; a subsidiary of McWane Inc.
 - 2. Standards: ASTM C1277 or CISPI 310.
 - 3. Description: Standard stainless steel corrugated shield with stainless steel bands and tightening devices; and ASTM C564, neoprene sleeve with integral, center pipe stop.
- D. Heavy-Duty, Hubless-Piping Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Husky SD4000.
 - b. Clamp All 125.
 - c. MG Products.
 - 2. Standards: ASTM C1540.
 - 3. Description: Type 304 stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, neoprene sleeve with integral, center pipe stop.

2.5 STAINLESS STEEL DRAINAGE PIPE AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Anvil International/Smith-Cooper International; Tailwind Capital, LLC.
 - 2. BLÜCHER; A Watts Water Technologies Company.
 - 3. Josam Company.

- B. Description: Comply with requirements of ASME A112.3.1 drainage pattern.
- C. Material: Type 304 stainless steel.
- D. Pipe Construction: Seamless.
- E. Internal Sealing Rings: EPDM.
- F. Joints: Single or double, socket and spigot ends.

2.6 COPPER TUBE AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - 2. Cambridge-Lee Industries, LLC.
 - 3. Cerro Flow Products, LLC.
 - 4. Wieland Copper Products, LLC.
- B. Copper Type DWV Tube: ASTM B306, drainage tube, drawn temper.
- C. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
- D. Hard Copper Tube: ASTM B88, Type L and Type M, water tube, drawn temper.
- E. Soft Copper Tube: ASTM B88, Type L, water tube, annealed temper.
- F. Copper Pressure Fittings:
 - 1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 - 2. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
- G. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
 - 1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - 2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- H. Solder: ASTM B32, lead free with ASTM B813, water-flushable flux.

2.7 PVC PIPE AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Charlotte Pipe and Foundry Company.

2. JM Eagle.
 3. North America Pipe Corporation.
-
- B. Comply with NSF 14 for plastic piping components. Include "NSF-dwv" marking for plastic drain, waste, and vent piping and "NSF-sewer" marking for plastic sewer piping.
 - C. Solid-Wall PVC Pipe: ASTM D2665 drain, waste, and vent.
 - D. PVC Socket Fittings: ASTM D2665, made in accordance with ASTM D3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
 - E. Adhesive Primer: ASTM F656.
 - F. Solvent Cement: ASTM D2564.

2.8 TRANSITION FITTINGS

- A. Install transition couplings at joints of piping with small differences in OD's. Refer to transition fitting products specified in Section 22 05 00 "Common Work Results for Plumbing".

2.9 DIELECTRIC FITTINGS

- A. Dielectric Unions and Flanges: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined. Comply with requirements in Section 22 05 00 "Common Work Results for Plumbing."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Examine conditions under which drainage and vent systems, e.g., storm drainage, sanitary sewer, laboratory waste, etc., are to be installed in coordination with Installer of materials and components specified in this Section. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to Installer.
 1. Verify invert elevation of existing piping when new connections are indicated. Do not install buried sewer work until existing sewer invert elevation has been verified to meet required slope and bury depth requirements of new sewer piping.
 2. Determine inverts and routing of piping systems and interferences with other building piping systems, building structure, lights, ductwork, foundations prior to installation.
- B. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 31 20 00 "Earth Moving."

3.3 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
 - 1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
 - 2. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping at indicated slopes.
- F. Install piping free of sags and bends.
- G. Install fittings for changes in direction and branch connections.
- H. Install vent piping to allow application of insulation within 10 feet of a roof penetration.
- I. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.
 - 1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
 - 2. Use long-turn, double Y-branch, and 1/8-bend fittings if two fixtures are installed back-to-back or side-by-side with common drainpipe.
 - a. Straight tees, elbows, and crosses may be used on vent lines.
 - 3. Do not change direction of flow more than 90 degrees.
 - 4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
 - a. Reducing size of waste piping in direction of flow is prohibited.

- J. Lay buried building waste piping beginning at low point of each system.
1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
 2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
 3. Maintain swab in piping and pull past each joint as completed.
- K. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:
1. Building Sanitary Waste: Two percent downward in direction of flow for piping NPS 2 and smaller; 1 percent downward in direction of flow for piping NPS 3 and larger.
 2. Horizontal Sanitary Waste Piping: Two percent downward in direction of flow.
 3. Vent Piping: One percent down toward vertical fixture vent or toward vent stack.
- L. Install cast-iron soil piping in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- M. Install stainless-steel piping according to ASME A112.3.1 and applicable plumbing code.
- N. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
- O. Install aboveground PVC piping according to ASTM D 2665.
- P. Install underground PVC piping according to ASTM D 2321.
- Q. Install engineered soil and waste drainage and vent piping systems as follows:
1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
- R. Plumbing Specialties:
1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.
 - a. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
 - b. Comply with requirements for cleanouts specified in Section 22 13 19 "Sanitary Waste Piping Specialties."
 2. Install drains in sanitary waste gravity-flow piping.
 - a. Comply with requirements for drains specified in Section 22 13 19 "Sanitary Waste Piping Specialties."
- S. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- T. Insulate vent piping within 10 feet of roof penetrations, all directions.
1. Comply with requirements for insulation specified in Section 22 07 19 "Plumbing Piping Insulation."

- U. Install sleeves for piping penetrations of walls, ceilings, and floors.
 - 1. Comply with requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."
- V. Install sleeve seals for piping penetrations of concrete walls and slabs.
 - 1. Comply with requirements for sleeve seals specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."
- W. Install escutcheons for piping penetrations of walls, ceilings, and floors.
 - 1. Comply with requirements for escutcheons specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

3.4 JOINT CONSTRUCTION

- A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Hub-and-Spigot, Cast-Iron Soil Piping Caulked Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum caulked joints.
- C. Hubless, Cast-Iron Soil Piping Coupled Joints:
 - 1. Join hubless, cast-iron soil piping in accordance with CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
- D. Join stainless-steel pipe and fittings with gaskets in accordance with ASME A112.3.1.
- E. Join copper tube and fittings with soldered joints in accordance with ASTM B828. Use ASTM B813, water-flushable, lead-free flux and ASTM B32, lead-free-alloy solder.
- F. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.
- G. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:
 - 1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. PVC Piping: Join in accordance with ASTM D2855 and ASTM D2665 appendixes.
- H. Joint Restraints and Sway Bracing:
 - 1. Provide joint restraints and sway bracing for storm drainage piping joints to comply with the following conditions:
 - a. Provide rigid sway bracing for pipe and fittings 4 inches and larger, upstream and downstream of all changes in direction 45 degrees and greater.

3.5 SPECIALTY PIPE FITTING INSTALLATION

- A. Comply with requirements for transition and dielectric fittings specified in Section 22 05 00 "Common Work Results for Plumbing."
- B. Transition Couplings:
 - 1. Install transition couplings at joints of piping with small differences in ODs.
 - 2. In Waste Drainage Piping: Shielded, nonpressure transition couplings.
- C. Dielectric Fittings:
 - 1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
 - 2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.
 - 3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges or flange kits.
 - 4. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.6 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements for pipe hanger and support devices and installation specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment".
 - 1. Install galvanized carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
 - 2. Install galvanized carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
 - 3. Vertical Piping: MSS Type 8 or Type 42 clamps.
 - 4. Install individual, straight, horizontal piping runs:
 - a. 100 Ft. and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Ft.: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Ft. if Indicated: MSS Type 49, spring cushion rolls.
 - 5. Multiple, Straight, Horizontal Piping Runs 100 Ft. or Longer: MSS Type 44 pipe rolls. Support pipe rolls on trapeze.
 - 6. Base of Vertical Piping: MSS Type 52 spring hangers.
- B. Install hangers for cast-iron, stainless steel and copper soil piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- C. Install hangers for PVC piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- D. Support horizontal piping and tubing within 12 inches of each fitting and coupling.

- E. Support vertical runs of cast-iron, stainless steel and copper soil piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- F. Support vertical runs of PVC piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect waste and vent piping to the following:
 - 1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
 - 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 - 3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
 - 4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
 - 5. Comply with requirements for cleanouts and drains specified in Section 22 13 19 "Sanitary Waste Piping Specialties."
 - 6. Equipment: Connect waste piping as indicated.
 - a. Provide shutoff valve if indicated and union for each connection.
 - b. Use flanges instead of unions for connections NPS 2-1/2 and larger.
- C. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- D. Make connections in accordance with the following unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.8 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping.
- B. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.9 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary waste and vent piping in accordance with procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.
 - a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.
 - a. Expose work that was covered or concealed before it was tested.
 - 3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.
 - a. Close openings in piping system and fill with water to point of overflow, but not less than 10 ft. head of water.
 - b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
 - c. Inspect joints for leaks.
 - 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.
 - a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1 inch wg.
 - b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
 - c. Air pressure must remain constant without introducing additional air throughout period of inspection.
 - d. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.10 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.
- D. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.
- E. Repair damage to adjacent materials caused by waste and vent piping installation.

3.11 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground, soil, waste and vent piping NPS 3 and smaller are to be any of the following:
 1. Service cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; CISPI 310, standard hubless-piping couplings; and coupled joints.
 3. Copper Type DWV tube, copper drainage fittings, and soldered joints.
 4. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- C. Aboveground, soil, waste and vent piping NPS 4 and larger are to be any of the following:
 1. Service cast iron, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
 3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- D. Aboveground, soil waste and vent pipe exposed to view in Kitchen areas shall be any of the following:
 1. Chrome plated, brass tubing.
 2. Stainless-steel pipe and fittings, sealing rings, and gasketed joints.
- E. Aboveground radon piping NPS 3 and smaller are to be the following:
 1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
- F. Underground, soil, waste, and vent piping NPS 12 and smaller are to be any of the following:
 1. Service cast-iron soil piping; gaskets; and gasketed joints.
 2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

- G. Underground radon piping NPS 3 and smaller are to be the following:
1. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

END OF SECTION 22 13 16

SECTION 22 13 19 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Cleanouts.
 - 2. Air-admittance valves.
 - 3. Roof flashing assemblies.
 - 4. Miscellaneous sanitary drainage piping specialties.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for the following:
 - 1. Floor cleanouts, general building areas.
 - 2. Wall cleanouts.
 - 3. Vent caps.
- B. As-Specified Data: If the product to be incorporated in the Work is as specified by manufacturer name and product designation in this Specification Section, submit the “**As-Specified Verification Form**” (attached to Section 01 33 00 “Submittal Procedures”) for each item listed below; otherwise submit full Product Data for the following:
 - 1. Fixture air-admittance valves.
 - 2. Deep-seal traps.
 - 3. Air-gap fittings.

1.4 CLOSEOUT SUBMITTALS

- A. Field quality-control reports.
- B. Operation and Maintenance Data: For sanitary waste piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTIONS

- A. Sanitary waste piping specialties shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic sanitary waste piping specialty components.

2.2 CLEANOUTS

A. Cast-Iron Exposed Cleanouts (CO):

- 1. Standard: ASME A112.36.2M.
- 2. Size: Same as connected drainage piping
- 3. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch or hubless, cast-iron soil pipe test tee as required to match connected piping.
- 4. Closure: Countersunk or raised-head, brass plug.
- 5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Stainless Steel Exposed Cleanouts:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. BLÜCHER; A Watts Water Technologies Company.
 - b. Josam Company.
- 2. Standard: ASME A112.3.1.
- 3. Size: Same as connected drainage piping.
- 4. Body Material: Stainless steel tee with side cleanout as required to match connected piping.
- 5. Closure: Stainless steel plug with seal.

C. Floor Cleanouts, General Building Areas (CODP):

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith Mfg. Co.; Division of Smith Industries, Inc.; No. 4021-U or comparable product by one of the following:
 - a. Josam Company.
 - b. MIFAB, Inc.
 - c. WATTS; A Watts Water Technologies Company; Model CO-200-R-6-CF.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation.
- 2. Standard: ASME A112.36.2M for adjustable housing cleanout.
- 3. Size: Same as connected branch.

4. Type: Adjustable threaded housing.
5. Body or Ferrule: Cast iron.
6. Outlet Connection: Spigot.
7. Closure: Brass plug with tapered threads or plastic plug and gasket.
8. Adjustable Housing Material: Nickel bronze with threads.
9. Frame and Cover Material and Finish: Nickel-bronze, copper alloy with scoriated, vandal resistant top.
10. Frame and Cover Shape: Square.
11. Top-Loading Classification: Medium Duty.
12. Riser: ASTM A74, Service Class, cast-iron drainage pipe fitting and riser to cleanout.

D. Wall Cleanouts (COWP):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith Mfg Co; a division of Morris Group International; No. 4531-U Series or a comparable product by one of the following:
 - a. Josam Company.
 - b. MIFAB, Inc.
 - c. WATTS; A Watts Water Technologies Company; Model CO-380-RD.
 - d. Zurn Industries, LLC.
2. Standard: ASME A112.36.2M, for cleanouts. Include wall access.
3. Size: Same as connected drainage piping.
4. Body Material: Hubless, cast-iron soil-pipe test tee as required to match connected piping.
5. Closure: Countersunk, drilled-and-threaded bronze plug and gasket.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with vandal resistant screw.

2.3 AIR-ADMITTANCE VALVES

A. Fixture Air-Admittance Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ayrlett, LLC.

- b. Oatey Co.
 - c. ProVent Systems.
 - d. Studor, Inc.
- 2. Standard: ASSE 1051, Type A for single fixture or Type B for branch piping.
- 3. Housing: Plastic.
- 4. Operation: Mechanical sealing diaphragm.
- 5. Size: Same as connected fixture or branch vent piping.

B. Wall Box for Air-Admittance Valves:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Oatey Co.
 - b. Sioux Chief Manufacturing Company, Inc.
 - c. Studor, Inc.
- 2. Description: White plastic housing with white plastic grille, made for recessed installation. Include bottom pipe connection and space to contain one air-admittance valve.
- 3. Size: Approximately 6 inches wide by 6 inches high by 4 inches deep.

2.4 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Deep-Seal Traps:

- 1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
- 2. Size: Same as connected waste piping.
 - a. NPS 2: 4-inch-minimum water seal.
 - b. NPS 2-1/2 and Larger: 5-inch-minimum water seal.

B. Air-Gap Fittings:

- 1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
- 2. Body: Bronze or cast iron.
- 3. Inlet: Opening in top of body.
- 4. Outlet: Larger than inlet.
- 5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

C. Vent Caps:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Thaler Metal Industries Ltd; Model VPC Vandalproof Vent Stack Cap with perforated collar or comparable product by one of the following:
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Watts Drainage Products Inc.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation
2. Description: Vandal-proof, .064" mill finish 1100 OT alloy aluminum vent stack cap with perforated collar, supporting cross member secured with vandal resistant stainless steel mounting screws.
3. Size: Same as connected stack vent or vent stack.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 2. Locate at each change in direction of piping greater than 45 degrees.
 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 4. Locate at base of each vertical soil and waste stack.
- B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- D. Install fixture air-admittance valves on fixture drain piping.
- E. Install air-admittance-valve wall boxes recessed in wall.
- F. Install deep-seal traps on floor drains and other waste outlets, if indicated.
- G. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- H. Install sleeve and sleeve seals with each riser and stack passing through floors with waterproof membrane.

- I. Install vent caps on each vent pipe passing through roof.
- J. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 PIPING CONNECTIONS

- A. Comply with requirements in Section 22 13 16 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment, to allow service and maintenance.

3.3 LABELING AND IDENTIFYING

- A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.
 - 1. Nameplates and signs are specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.4 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 13 19

SECTION 22 13 19.13 - SANITARY DRAINS**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Floor drains.
- 2. Floor sinks.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for the following:
 - 1. Floor drain "A".
 - 2. Floor drain "B".
 - 3. Floor sink "A".
 - 4. Floor sink "B".
 - 5. Inline trap seal device.

PART 2 - PRODUCTS**2.1 DRAIN ASSEMBLIES**

- A. Sanitary drains shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic sanitary piping specialty components.

2.2 FLOOR DRAINS

- A. Cast-Iron Floor Drains (FD "A"):
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith Mfg Co; a division of Morris Group International; No. 2005 or a comparable product by one of the following:
 - a. Josam Company.
 - b. MIFAB, Inc.

- c. WATTS; A Watts Water Technologies Company.
 - d. Zurn Industries, LLC.
- 2. Standard: ASME A112.6.3.
- 3. Pattern: Floor drain.
- 4. Body Material: Gray iron.
- 5. Outlet: Bottom.
- 6. Backwater Valve: Not required.
- 7. Top of Body and Strainer Finish: Nickel bronze.
- 8. Top Shape: Square.
- 9. Dimensions of Top or Strainer: 7-inch square.
- 10. Top Loading Classification: Light Duty.
- 11. Trap Material: Cast iron.
- 12. Trap Pattern: Deep-seal P-trap.
- 13. Trap Features: Floor drain inline trap seal.

B. Cast-Iron Floor Drains (FD “B”):

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith Mfg Co; a division of Morris Group International; No. 2270 or a comparable product by one of the following:
 - a. Josam Company.
 - b. MIFAB, Inc.
 - c. WATTS; A Watts Water Technologies Company.
 - d. Zurn Industries, LLC.
- 2. Standard: ASME A112.6.3.
- 3. Pattern: Floor drain.
- 4. Body Material: Gray iron.
- 5. Outlet: Bottom.
- 6. Backwater Valve: Not required.
- 7. Top of Body and Strainer Finish: Galvanized cast iron.
- 8. Top Shape: Round.

9. Dimensions of Top or Strainer: 8.5-inch diameter.
10. Top Loading Classification: Medium duty.
11. Trap Material: Cast iron.
12. Trap Pattern: Deep-seal P-trap.
13. Trap Features: Floor drain inline trap seal.

2.3 FLOOR SINKS

A. Cast-Iron Floor Sinks (FS "A"):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith Mfg Co; a division of Morris Group International; No. 3150C-C-12 or a comparable product by one of the following:
 - a. Josam Company.
 - b. MIFAB, Inc.
 - c. WATTS; A Watts Water Technologies Company.
 - d. Zurn Industries, LLC.
2. Standard: ASME A112.6.7.
3. Pattern: Floor drain.
4. Body Material: Cast iron.
5. Anchor Flange: Required.
6. Clamping Device: Not required.
7. Outlet: Bottom, no-hub connection.
8. Coating on Interior Surfaces: Acid-resistant enamel.
9. Sediment Bucket: Not required.
10. Internal Strainer: Dome.
11. Internal Strainer Material: Aluminum.
12. Top Grate Material: Cast iron, loose.
13. Top of Body and Grate Finish: Nickel bronze.
14. Top Shape: Square.
15. Dimensions of Top Grate: 12-1/2 inches, half grate.

16. Top Loading Classification: No traffic.

17. Funnel: Not required.

B. Cast-Iron Floor Sinks (FS “B”):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith Mfg Co; a division of Morris Group International; No. 3150C-C-19 or a comparable product by one of the following:

- a. Josam Company.
- b. MIFAB, Inc.
- c. WATTS; A Watts Water Technologies Company.
- d. Zurn Industries, LLC.

2. Standard: ASME A112.6.7.

3. Pattern: Floor drain.

4. Body Material: Cast iron.

5. Anchor Flange: Required.

6. Clamping Device: Not required.

7. Outlet: Bottom, no-hub connection.

8. Coating on Interior Surfaces: Acid-resistant enamel.

9. Sediment Bucket: Not required.

10. Internal Strainer: Dome.

11. Internal Strainer Material: Aluminum.

12. Top Grate Material: Cast iron, loose.

13. Top of Body and Grate Finish: Nickel bronze.

14. Top Shape: Square.

15. Dimensions of Top Grate: 12-1/2 inches, hinged ADA grate.

16. Top Loading Classification: No traffic.

17. Funnel: Not required.

2.4 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Floor-Drain, Inline Trap Seal:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith Mfg Co; a division of Morris Group International; Quad Close Trap Seal No. 2962 or a comparable product by one of the following:
 - a. Green Drain, Inc.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. RectorSeal Plumbing; A CSW Industrials Company.
2. Description: Inline floor drain trap seal, forming a physical barrier to slow trap evaporation while not impeding flow from drain.
3. Material: Polymer.
4. Standard: Tested and certified in accordance with ASSE 1072.
5. Listing: ICC-ES or IAPMO listed.
6. Size: Same as floor drain outlet or strainer throat.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 1. Position floor drains for easy access and maintenance.
 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.
 3. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
 - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
 - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
 4. Install floor-drain flashing collar or flange, so no leakage occurs between drain and adjoining flooring.
 - a. Maintain integrity of waterproof membranes where penetrated.
 5. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

3.2 CONNECTIONS

- A. Comply with requirements in Section 22 13 16 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Comply with requirements in Section 22 13 19 "Sanitary Waste Piping Specialties" for backwater valves, air admittance devices and miscellaneous sanitary drainage piping specialties.
- C. Comply with requirements in Section 22 13 23 "Sanitary Waste Interceptors" for grease interceptors, grease-removal devices, oil interceptors, sand interceptors, and solid interceptors.
- D. Install piping adjacent to equipment to allow service and maintenance.
- E. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

3.3 LABELING AND IDENTIFYING

- A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.4 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 13 19.13

SECTION 22 13 23 - SANITARY WASTE INTERCEPTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Grease interceptors.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of metal interceptor. Include materials of fabrication, dimensions, rated capacities, retention capacities, operating characteristics, size and location of each pipe connection, furnished specialties, and accessories.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For sanitary waste interceptors to include in emergency, operation, and maintenance manuals.

1.5 FIELD CONDITIONS

- A. Interruption of Existing Sewer Services: Do not interrupt services to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sewer services according to requirements indicated:
 - 1. Notify Construction Manager no fewer than seven days in advance of proposed interruption of service.
 - 2. Do not proceed with interruption of sewer services without Construction Manager's written permission.

PART 2 - PRODUCTS

2.1 GREASE INTERCEPTORS

A. Cast-Iron or Steel Grease Interceptors (GI-1):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith Mfg Co; a division of Morris Group International; Model No. 8250-F-B-ARIO-AC or a comparable product by one of the following:
 - a. Josam Company.
 - b. MIFAB, Inc.
 - c. WATTS; A Watts Water Technologies Company.
 - d. Zurn Industries, LLC.
2. Standard: PDI G101 and ASME A112.14.3, for intercepting and retaining FOG from food preparation wastewater.
3. PDI Seal: Required.
4. Body Material: Steel.
5. Interior Lining: Corrosion-resistant enamel.
6. Exterior Coating: Corrosion-resistant enamel.
7. Body Extension: Required.
8. Capacities and Characteristics: Refer to Schedules on Drawings.

2.2 LABELING AND IDENTIFYING

- #### A. Grease Interceptor Warning Sign: Refer to Section 22 05 53 "Identification for Plumbing Piping and Equipment" for warning signs and basic installation requirements.

PART 3 - EXECUTION

3.1 EARTHWORK

- #### A. Excavating, trenching, and backfilling are specified in Section 31 20 00 "Earth Moving."

3.2 INSTALLATION

- #### A. Set tops of grating frames and grates flush with finished surface.
- #### B. Set metal interceptors level and plumb.

- C. Install grease interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing.
 - 1. Flush with Floor Installation: Set unit and extension, if required, with cover flush with finished floor.
 - 2. Install cleanout immediately downstream from interceptors not having integral cleanout on outlet.

3.3 PIPING CONNECTIONS

- A. Piping installation requirements are specified in Section 22 13 16 "Sanitary Waste and Vent Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Make piping connections between interceptors and piping systems.

3.4 IDENTIFICATION

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. Grease interceptors.

3.5 PROTECTION

- A. Protect sanitary waste interceptors from damage during construction period.
- B. Repair damage to adjacent materials caused by sanitary waste interceptor installation.

END OF SECTION 22 13 23

SECTION 22 14 14 - STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipe, tube, and fittings.
 - 2. Specialty pipe fittings.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. Hub-and-spigot, cast-iron soil pipe and fittings.
 - 2. Hubless, cast-iron soil pipe and fittings.
 - 3. Heavy-duty, high torque hubless-piping couplings.
- B. As-Specified Data: If the product to be incorporated in the Work is as specified by manufacturer name and product designation in this Specification Section, submit the “**As-Specified Verification Form**” (attached to Section 01 33 00 “Submittal Procedures”) for each item listed below; otherwise submit full Product Data for the following:
 - 1. CISPI, standard hubless-piping couplings.
 - 2. Transition couplings.

1.4 CLOSEOUT SUBMITALS

- A. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

1.6 FIELD CONDITIONS

- A. Interruption of Existing Storm Drainage Sewer: Refer to “Existing Utility Interruptions” paragraph of Section 01 12 00 “Multiple Contract Summary-Project Schedule” for requirements associated with interrupting the existing storm sewer service to facilities occupied by the Owner.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Components and installation are capable of withstanding the following minimum working pressure unless otherwise indicated:
 - 1. Storm Drainage Piping: 10 ft. head of water.

2.2 PIPING MATERIALS

- A. Piping materials to bear label, stamp, or other markings of specified testing agency.
- B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AB & I Foundry; a part of the McWane family of companies.
 - 2. Charlotte Pipe and Foundry Company.
 - 3. Tyler Pipe; a part of McWane family of companies.
- B. Pipe and Fittings: Centrifugally cast gray cast iron pipe and static cast fittings conforming to requirements of ASTM Standard A 74, service weight (SV) type. Pipe and fittings marked with the collective trademark of the Cast Iron Soil Institute and listed by NSF® International.
- C. Gaskets: ASTM C564, rubber.
- D. Caulking Materials: ASTM B29, pure lead and oakum or hemp fiber.

2.4 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AB & I Foundry; a part of the McWane family of companies.
 - 2. Charlotte Pipe and Foundry Company.
 - 3. Tyler Pipe; a part of McWane family of companies.
- B. Pipe and Fittings: Centrifugally cast gray cast iron pipe and static cast fittings conforming to requirements of ASTM A 888 or CISPI 301. Pipe and fittings marked with the collective trademark of the Cast Iron Soil Institute and listed by NSF® International.

C. CISPI, Standard Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ANACO.
 - b. Ideal Tridon Group.
 - c. Mission Rubber Company, LLC; a division of MCP Industries.
 - d. Tyler Pipe; a subsidiary of McWane Inc.
2. Standards: ASTM C1277 or CISPI 310.
3. Description: Standard stainless steel corrugated shield with stainless steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

D. Heavy-Duty, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Huky SD 4000.
 - b. Clamp All 125.
 - c. MG Products.
2. Standards: ASTM C1540.
3. Description: Type 304 stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.5 TRANSITION FITTINGS

- A. Install transition couplings at joints of piping with small differences in OD's. Refer to transition fitting products specified in Section 22 05 00 "Common Work Results for Plumbing".

2.6 DIELECTRIC FITTINGS

- A. Dielectric Unions and Flanges: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined. Comply with requirements in Section 22 05 00 "Common Work Results for Plumbing."

PART 3 - EXECUTION

3.1 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 31 20 00 "Earth Moving."

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
 - 1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
 - 2. Install piping as indicated unless deviations from layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Make changes in direction for piping using appropriate branches, bends, and long-sweep bends.
 - 1. Do not change direction of flow more than 90 degrees.
 - 2. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
 - a. Reducing size of drainage piping in direction of flow is prohibited.
- K. Lay buried building piping beginning at low point of each system.
 - 1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
 - 2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
 - 3. Maintain swab in piping and pull past each joint as completed.
- L. Install piping at the following minimum slopes unless otherwise indicated:
 - 1. Building Storm Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
 - 2. Horizontal Storm Drainage Piping: 1 percent downward in direction of flow.

- M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- N. Plumbing Specialties:
 - 1. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers in storm drainage gravity-flow piping.
 - a. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.
 - b. Comply with requirements for cleanouts specified in Section 22 14 23 "Storm Drainage Piping Specialties."
 - 2. Install drains in storm drainage gravity-flow piping.
 - a. Comply with requirements for drains specified in Section 22 14 23 "Storm Drainage Piping Specialties."
- O. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- P. Install sleeves for piping penetrations of walls, ceilings, and floors.
 - 1. Comply with requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."
- Q. Install sleeve seals for piping penetrations of concrete walls and slabs.
 - 1. Comply with requirements for sleeve seals specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."
- R. Install escutcheons for piping penetrations of walls, ceilings, and floors.
 - 1. Comply with requirements for escutcheons specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

- A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Hubless, Cast-Iron Soil Piping Coupled Joints:
 - 1. Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

C. Joint Restraints and Sway Bracing:

1. Provide joint restraints and sway bracing for storm drainage piping joints to comply with the following conditions:
 - a. Provide axial restraint for pipe and fittings 5 inches larger, upstream and downstream of all changes in direction, branches, and changes in diameter greater than two pipe sizes.
 - b. Provide rigid sway bracing for pipe and fittings 4 inches and larger, upstream and downstream of all changes in direction 45 degrees and greater.
 - c. Provide rigid sway bracing for pipe and fittings 5 inches and larger, upstream and downstream of all changes in direction and branch openings.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in ODs.
2. In Drainage Piping: Shielded, nonpressure transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flange.
4. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.5 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for hangers, supports, and anchor devices specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
3. Vertical Piping: MSS Type 8 or Type 42, clamps.
4. Install individual, straight, horizontal piping runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
5. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
6. Base of Vertical Piping: MSS Type 52, spring hangers.

- B. Support horizontal piping and tubing within 12 inches of each fitting, and coupling.
- C. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
- D. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 3: 60 inches with 1/2-inch rod.
 - 2. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
 - 3. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
 - 4. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
- E. Install supports for vertical cast-iron soil piping every 15 feet.
- F. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4: 84 inches with 3/8-inch rod.
 - 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 - 3. NPS 2: 10 feet with 3/8-inch rod.
 - 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
 - 5. NPS 3: 12 feet with 1/2-inch rod.
 - 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
 - 7. NPS 6 and NPS 8: 12 feet with 3/4-inch rod.
- G. Install supports for vertical steel piping every 15 feet.
- H. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect storm drainage piping to roof drains and storm drainage specialties.
 - 1. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.
 - 2. Comply with requirements for cleanouts and drains specified in Section 22 14 23 "Storm Drainage Piping Specialties."
- D. Where installing piping adjacent to equipment, allow space for service and maintenance.

3.7 IDENTIFICATION

- A. Identify exposed storm drainage piping.
- B. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.8 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.
 - a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved.
 - a. Expose work that was covered or concealed before it was tested.
 - 3. Test Procedure:
 - a. Test storm drainage piping, on completion of roughing-in.
 - b. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.
 - 4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 5. Prepare reports for tests and required corrective action.
- C. Piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.9 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.10 PIPING SCHEDULE

- A. Aboveground storm drainage piping NPS 3 and smaller shall be any of the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2. Hubless, cast-iron soil pipe and fittings; heavy duty, hubless-piping couplings; and coupled joints.
 - 3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- B. Aboveground, storm drainage piping NPS 4 and larger shall be any of the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2. Hubless, cast-iron soil pipe and fittings; heavy-duty, hubless-piping couplings; and coupled joints.
 - 3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- C. Underground storm drainage piping shall be any of the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

END OF SECTION 22 14 14

SECTION 22 14 23 - STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Roof drains.
 - 2. Miscellaneous storm drainage piping specialties.
 - 3. Cleanouts.
 - 4. Backwater valves.
 - 5. Flashing materials.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. Cast-iron, large-sump, general-purpose roof drains.
 - 2. Cast-iron, large-sump, overflow roof drains.
 - 3. Downspout nozzle.
 - 4. Drain-outlet backwater valves.
 - 5. Floor cleanouts, general building areas.
 - 6. Wall cleanouts.

1.4 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 METAL ROOF DRAINS

- A. Cast-Iron, Large-Sump, General-Purpose Roof Drains (RD "A"):
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith Mfg. Co.; Division of Smith Industries, Inc.; No. 1015Y-R-C-U-G or comparable product by one of the following:
 - a. Josam Company.

- b. MIFAB, Inc.
 - c. WATTS; A Watts Water Technologies Company; No. RD-300-AE-B-D-K80-L.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation.
- 2. Standard: ASME A112.6.4, for general-purpose roof drains.
- 3. Body Material: Cast iron.
- 4. Dimension of Body: Nominal 16-inch diameter.
- 5. Combination Flashing Ring and Gravel Stop: Required.
- 6. Outlet: Bottom.
- 7. Extension Collars: Adjustable required.
- 8. Underdeck Clamp: Required.
- 9. Sump Receiver Plate: Required.
- 10. Dome Material: Galvanized Cast Iron.
- 11. Vandal-Proof Dome: Required.

B. Cast-Iron, Large-Sump, Overflow Roof Drains (RD “B):

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith Mfg. Co.; Division of Smith Industries, Inc.; No. 1074Y-R-C-U-G or comparable product by one of the following:
 - a. Josam Company.
 - b. MIFAB, Inc.
 - c. WATTS; A Watts Water Technologies Company; No. RD-300-AE-B-D-K80-L-R.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation.
- 2. Standard: ASME A112.6.4, for general-purpose roof drains.
- 3. Body Material: Cast iron.
- 4. Dimension of Body: Nominal 16-inch diameter.
- 5. Combination Flashing Ring and Gravel Stop: Required.
- 6. Outlet: Bottom.
- 7. Extension Collars: Adjustable required.
- 8. Underdeck Clamp: Required.
- 9. Sump Receiver Plate: Required.
- 10. Dome Material: Galvanized Cast Iron.

11. Vandal-Proof Dome: Required.
12. Water Dam: 2 inches high.

2.2 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Downspout Nozzles:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith Mfg. Co.; Division of Smith Industries, Inc.; No. 1771-BS or comparable product by one of the following:
 - a. Josam Company.
 - b. MIFAB, Inc.
 - c. WATTS; A Watts Water Technologies Company; Model RD-940-NH-83.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Body Material: Cast brass.
3. Outlet: No-hub adaptor.
4. Bird Screen: Stainless steel.
5. Size: Same as connected conductor.

B. Drain-Outlet Backwater Valves:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith Mfg. Co.; Division of Smith Industries, Inc.; No. 7080 or comparable product by one of the following:
 - a. Josam Company.
 - b. MIFAB, Inc.
 - c. WATTS; A Watts Water Technologies Company; Model BV-300.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Size: Same as floor drain outlet or storm drain.
3. Body: Cast iron or bronze made for vertical installation in bottom outlet of floor drain or in vertical storm leader for condensate connection.
4. Check Valve: Removable ball float.
5. Inlet: Threaded.
6. Outlet: Threaded or spigot.

2.3 CLEANOUTS

A. Exposed Metal Cleanouts (CO):

1. Vertical 6 NPS and Smaller:
 - a. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
 - b. Size: Same as connected drainage piping
 - c. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch or hubless, cast-iron soil pipe test tee as required to match connected piping.
 - d. Closure: Countersunk or raised-head, brass plug.
 - e. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
2. 8-inch Pipe Size and Larger: Cast bronze tapered plug with tapped test tee cast iron fitting.
3. Horizontal: All Pipe Sizes: Cast iron Tee “Y” fitting with tapped spigot ferrule and cast bronze taper thread plug.

B. Floor Cleanouts (CODP):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith Mfg. Co.; Division of Smith Industries, Inc.; No. 4021-U or comparable product by one of the following:
 - a. Josam Company.
 - b. MIFAB, Inc.
 - c. WATTS; A Watts Water Technologies Company; Model CO-200-R-6-CF.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M, for adjustable housing cleanouts.
3. Size: Same as connected branch.
4. Type: Adjustable housing.
5. Body or Ferrule Material: Cast iron.
6. Outlet Connection: Spigot.
7. Closure: Brass plug with straight threads and gasket or plastic plug and gasket.
8. Adjustable Housing Material: Nickel-bronze with threads.
9. Frame and Cover Material and Finish: Nickel-bronze, copper alloy with scoriated, vandal resistant top.
10. Frame and Cover Shape: Round.
11. Top-Loading Classification: Medium Duty.

12. Carpet Clamping Collar: Required in carpeted areas.
13. Riser: ASTM A 74, Extra-Heavy or Service class, cast-iron drainage pipe fitting and riser to cleanout.

C. Wall Cleanouts (COWP):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith Mfg. Co.; Division of Smith Industries, Inc.; No. 4531-U or comparable product by one of the following:
 - a. Josam Company.
 - b. MIFAB, Inc.
 - c. WATTS; A Watts Water Technologies Company; Model CO-380-RD.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M, for cleanouts. Include wall access.
3. Size: Same as connected drainage piping.
4. Body Material: Hubless, cast-iron soil-pipe test tee as required to match connected piping.
5. Closure: Countersunk, drilled-and-threaded bronze plug and gasket.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with vandal resistant screw.

2.4 FLASHING MATERIALS

- A. Copper Sheet: ASTM B 152/B 152M, 12 oz./sq. ft.
- B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.
- C. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.
- D. Fasteners: Metal compatible with material and substrate being fastened.
- E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
- F. Solder: ASTM B 32, lead-free alloy.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of storm drainage piping systems to verify actual locations of specialties installations.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 INSTALLATION

- A. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions.
 - 1. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
 - 2. Position roof drains for easy access and maintenance.
- B. Install downspout adapters on outlet of back-outlet parapet roof drains and connect to sheet metal downspouts.
- C. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.
- D. Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:
 - 1. Use cleanouts the same size as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
 - 3. Locate cleanouts at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 - 4. Locate cleanouts at base of each vertical soil and waste stack.
- E. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- F. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- G. Install drain-outlet backwater valves in condensate connections to vertical conductors.
- H. Install test tees in vertical conductors and near floor.
- I. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.
- J. Install sleeve flashing device with each conductor passing through floors with waterproof membrane.

3.3 CONNECTIONS

- A. Comply with requirements for piping specified in Section 22 14 13 "Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

3.4 FLASHING INSTALLATION

- A. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
 - 1. Lead Sheets: Burn joints of 6.0-lb/sq. ft. lead sheets, 0.0938-inch thickness or thicker. Solder joints of 4.0-lb/sq. ft. lead sheets, 0.0625-inch thickness or thinner.
 - 2. Copper Sheets: Solder joints of copper sheets.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 - 1. Pipe Flashing: Sleeve type, matching the pipe size, with a minimum length of 10 inches and with skirt or flange extending at least 8 inches around pipe.
 - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
 - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.
- E. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.5 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 14 23

SECTION 22 15 13 - GENERAL-SERVICE COMPRESSED-AIR PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes piping and related specialties for general-service compressed-air systems operating at 150 psig or less.

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. CR: Chlorosulfonated polyethylene synthetic rubber.
- C. EPDM: Ethylene-propylene-diene terpolymer rubber.
- D. HDPE: High-density polyethylene plastic.
- E. NBR: Acrylonitrile-butadiene rubber.
- F. PE: Polyethylene plastic.
- G. PVC: Polyvinyl chloride plastic.

1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Dielectric fittings.
 - 2. Flexible pipe connectors
 - 3. Safety valves.
 - 4. Pressure regulators. Include rated capacities and operating characteristics.
 - 5. Automatic drain valves.
 - 6. Filters. Include rated capacities and operating characteristics.
 - 7. Lubricators. Include rated capacities and operating characteristics.
 - 8. Quick couplings.
 - 9. Hose assemblies.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For general-service compressed-air piping specialties to include in emergency, operation, and maintenance manuals.
- B. Field quality-control test reports.

1.6 QUALITY ASSURANCE

- A. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or to AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."
- B. ASME Compliance:
 - 1. Comply with ASME B31.1, "Power Piping," for high-pressure compressed-air piping.
 - 2. Comply with ASME B31.9, "Building Services Piping," for low-pressure compressed-air piping.

1.7 PROJECT CONDITIONS

- A. Interruption of Existing Compressed-Air Service: Refer to "Existing Utility Interruptions" paragraph of Section 01 12 00 "Multiple Contract Summary-Project Schedule" for requirements associated with interrupting the existing compressed-air to facilities occupied by the Owner.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

- A. Schedule 40, Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B, black or hot-dip zinc coated with ends threaded according to ASME B1.20.1.
 - 1. Steel Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, galvanized seamless steel pipe. Include ends matching joining method.
 - 2. Malleable-Iron Fittings: ASME B16.3, Class 150 or 300, threaded.
 - 3. Malleable-Iron Unions: ASME B16.39, Class 150 or 300, threaded.
 - 4. Steel Flanges: ASME B16.5, Class 150 or 300, carbon steel, threaded.
 - 5. Wrought-Steel Butt-Welding Fittings: ASME B16.9, Schedule 40.
 - 6. Steel Flanges: ASME B16.5, Class 150 or 300, carbon steel.
 - 7. Grooved-End Fittings and Couplings:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Anvil International, Inc.
 - 2) Star Pipe Products; Star Fittings Div.
 - 3) Victaulic Company.
 - 4) Ward Manufacturing, Inc.

- b. Grooved-End Fittings: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron casting; with grooves according to AWWA C606 and dimensions matching steel pipe.
 - c. Couplings: AWWA C606 or UL 213, for steel-pipe dimensions and rated for 300-psig minimum working pressure. Include ferrous housing sections, gasket suitable for compressed air, and bolts and nuts. Provide EDPM gaskets for oil-free compressed air. Provide NBR gaskets if compressed air contains oil or oil vapor.
- B. Copper Tube: ASTM B 88, Type K or L seamless, drawn-temper, water tube.
 - 1. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, wrought copper with dimensions for brazed joints.
 - 2. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150 or 300.
 - 3. Copper Unions: ASME B16.22 or MSS SP-123.
 - 4. Grooved-End Fittings and Couplings:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Anvil International, Inc.
 - 2) Victaulic Company.
 - b. Grooved-End Fittings: ASTM B 75, copper tube or ASTM B 584, bronze castings.
 - c. Couplings: Copper-tube dimensions and design similar to AWWA C606. Include ferrous housing sections, gasket suitable for compressed air, and bolts and nuts. Provide EDPM gasket for oil-free compressed air. Provide NBR gasket if compressed air contains oil or oil vapor.
- C. Transition Couplings for Metal Piping: Metal coupling or other manufactured fitting same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.2 JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for compressed-air piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

- D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated.
- E. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.3 VALVES

- A. Metal Ball, Butterfly, Check, Gate, and Globe Valves: Comply with requirements in Section 22 05 23 "General-Duty Valves for Plumbing Piping."

2.4 DIELECTRIC FITTINGS

- A. Dielectric Unions and Flanges: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined. Comply with requirements in Section 22 05 00 "Common Work Results for Plumbing."

2.5 FLEXIBLE PIPE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Flex-Hose Co., Inc.
 - 2. Flexicraft Industries.
 - 3. Hyspan Precision Products, Inc.
 - 4. Mercer Rubber Co.
 - 5. Metraflex, Inc.
 - 6. Proco Products, Inc.
 - 7. Unaflex, Inc.
 - 8. Universal Metal Hose; a Hyspan Company.
- B. Stainless-Steel-Hose Flexible Pipe Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
 - 1. Working-Pressure Rating: 200 psig minimum.
 - 2. End Connections, NPS 2 and Smaller: Threaded steel pipe nipple.
 - 3. End Connections, NPS 2-1/2 and Larger: Flanged steel nipple.

2.6 SPECIALTIES

- A. Safety Valves: ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," construction; National Board certified, labeled, and factory sealed; constructed of bronze body with poppet-type safety valve for compressed-air service.
 - 1. Pressure Settings: Higher than discharge pressure and same or lower than receiver pressure rating.

- B. Air-Line Pressure Regulators: Diaphragm operated, aluminum alloy or plastic body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 200-psig minimum inlet pressure, unless otherwise indicated.
- C. Automatic Drain Valves: Stainless-steel body and internal parts, rated for 200-psig minimum working pressure, capable of automatic discharge of collected condensate. Include mounting bracket if wall mounting is indicated.
- D. Mechanical Filters: Two-stage, mechanical-separation-type, air-line filters. Equip with deflector plates, resin-impregnated-ribbon-type filters with edge filtration, and drain cock. Include mounting bracket if wall mounting is indicated.

2.7 QUICK COUPLINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Aeroquip Corporation; Eaton Corp.
 - 2. Bowes Manufacturing Inc.
 - 3. Foster Manufacturing, Inc.
 - 4. Milton Industries, Inc.
 - 5. Parker Hannifin Corp.; Fluid Connectors Group; Quick Coupling Div.
 - 6. Rectus Corp.
 - 7. Schrader-Bridgeport; Amflo Div. Schrader-Bridgeport/Standard Thomson.
 - 8. Snap-Tite, Inc.; Quick Disconnect & Valve Division.
 - 9. TOMCO Products Inc.
 - 10. Tuthill Corporation; Hansen Coupling Div.
- B. General Requirements for Quick Couplings: Assembly with locking-mechanism feature for quick connection and disconnection of compressed-air hose.
- C. Valveless Quick Couplings: Straight-through brass body with stainless-steel or nickel-plated-steel operating parts.
 - 1. Socket End: With O-ring or gasket seal, without valve, and with barbed inlet for attaching hose.
 - 2. Plug End: With barbed outlet for attaching hose.

2.8 HOSE ASSEMBLIES

- A. Description: Compatible hose, clamps, couplings, and splicers suitable for compressed-air service, of nominal diameter indicated, and rated for 300-psig minimum working pressure, unless otherwise indicated.
 - 1. Hose: Reinforced single-wire-braid, CR-covered hose for compressed-air service.
 - 2. Hose Clamps: Stainless-steel clamps or bands.

3. Hose Couplings: Two-piece, straight-through, threaded brass or stainless-steel O-ring or gasket-seal swivel coupling with barbed ends for connecting two sections of hose.
4. Hose Splicers: One-piece, straight-through brass or stainless-steel fitting with barbed ends for connecting two sections of hose.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Compressed-Air Distribution Piping: Use one of the following piping materials for each size range:
 1. NPS 2 and Smaller: Schedule 40, black-steel pipe; threaded, malleable-iron fittings; and threaded joints.
 2. NPS 2 and Smaller: Type K or L, copper tube; wrought-copper fittings; and brazed joints.
- B. Drain Piping: Use the following piping materials:
 1. NPS 2 and Smaller: Type M copper tube; wrought-copper fittings; and brazed or soldered joints.

3.2 VALVE APPLICATIONS

- A. General-Duty Valves: Comply with requirements in Section 220523 "General-Duty Valves for Plumbing Piping" for metal general-duty valves. Use metal valves, unless otherwise indicated.
 1. Metal General-Duty Valves: Use valve types specified in "Valve Applications" Article in Section 22 05 23 "General-Duty Valves for Plumbing Piping" according to the following:
 - a. Low-Pressure Compressed Air: Valve types specified for low-pressure compressed air.
 - b. Equipment Isolation NPS 2 and Smaller: Safety-exhaust, copper-alloy ball valve with exhaust vent and pressure rating at least as great as piping system operating pressure.
 - c. Grooved-end valves may be used with grooved-end piping and grooved joints.

3.3 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of compressed-air piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install piping concealed from view and protected from physical contact by building occupants, unless otherwise indicated and except in equipment rooms and service areas.

- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited, unless otherwise indicated.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and to coordinate with other services occupying that space.
- E. Install piping adjacent to equipment and machines to allow service and maintenance.
- F. Install air and drain piping with 1 percent slope downward in direction of flow.
- G. Install nipples, flanges, unions, transition and special fittings, and valves with pressure ratings same as or higher than system pressure rating, unless otherwise indicated.
- H. Equipment and Specialty Flanged Connections:
 - 1. Use steel companion flange with gasket for connection to steel pipe.
 - 2. Use cast-copper-alloy companion flange with gasket and brazed joint for connection to copper tube. Do not use soldered joints for connection to air compressors or to equipment or machines producing shock or vibration.
- I. Flanged joints may be used instead of specified joint for any piping or tubing system.
- J. Extended-tee outlets with brazed branch connection may be used for copper tubing, within extruded-tee connection diameter to run tube diameter ratio for tube type, according to Extruded Tee Connections Sizes and Wall Thickness for Copper Tube (Inches) Table in ASTM F 2144.
- K. Install eccentric reducers where compressed-air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.
- L. Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.
- M. Install thermometer and pressure gage on discharge piping from each air compressor and on each receiver. Comply with requirements in Section 22 05 19 "Meters and Gages for Plumbing Piping."
- N. Install piping to permit valve servicing.
- O. Install piping free of sags and bends.
- P. Install fittings for changes in direction and branch connections.
- Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."
- R. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."
- S. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

3.4 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. Welded Joints for Steel Piping: Join according to AWS D10.12/D10.12M.
- E. Brazed Joints for Copper Tubing: Join according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
- F. Flanged Joints: Use asbestos-free, nonmetallic gasket suitable for compressed air. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.
- G. Grooved Joints: Assemble couplings with housing, gasket, lubricant, and bolts. Join according to AWWA C606 for grooved joints. Do not apply lubricant to prelubricated gaskets.
- H. Dissimilar Metal Piping Material Joints: Use dielectric fittings.

3.5 VALVE INSTALLATION

- A. General-Duty Valves: Comply with requirements in Section 22 05 23 "General-Duty Valves for Plumbing Piping."
- B. Install shutoff valves and unions or flanged joints at compressed-air piping to air compressors.
- C. Install shutoff valve at inlet to each automatic drain valve, filter, lubricator, and pressure regulator.
- D. Install check valves to maintain correct direction of compressed-air flow to and from compressed-air piping specialties and equipment.

3.6 DIELECTRIC FITTING INSTALLATION

- A. Comply with requirements for dielectric fittings specified in Section 22 05 00 "Common Work Results for Plumbing."
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or unions.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges or flange kits.
- D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.7 FLEXIBLE PIPE CONNECTOR INSTALLATION

- A. Install flexible pipe connectors in discharge piping of each air compressor.
- B. Install stainless-steel-hose flexible pipe connectors in steel compressed-air piping.

3.8 SPECIALTY INSTALLATION

- A. Install safety valves on receivers in quantity and size to relieve at least the capacity of connected air compressors.
- B. Install air-main pressure regulators in compressed-air piping at or near air compressors.
- C. Install air-line pressure regulators in branch piping to equipment.
- D. Install automatic drain valves on aftercoolers, receivers, and dryers. Discharge condensate onto nearest floor drain.
- E. Install mechanical filters in compressed-air piping at or near air compressors and downstream from coalescing filters. Mount on wall at locations indicated.
- F. Install quick couplings at piping terminals for hose connections.
- G. Install hose assemblies at hose connections.

3.9 CONNECTIONS

- A. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment and machine.
- B. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment and machine.

3.10 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.
- B. Vertical Piping: MSS Type 8 or 42, clamps.
- C. Individual, Straight, Horizontal Piping Runs:
 - 1. 100 Feet or Less: MSS Type 1, adjustable, steel clevis hangers.
 - 2. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
- D. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
- E. Base of Vertical Piping: MSS Type 52, spring hangers.
- F. Support horizontal piping within 12 inches of each fitting and coupling.
- G. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- H. Install hangers for Schedule 40, steel piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1/4 to NPS 1/2: 96 inches with 3/8-inch rod.
 - 2. NPS 3/4 to NPS 1-1/4: 84 inches with 3/8-inch rod.
 - 3. NPS 1-1/2: 12 feet with 3/8-inch rod.
 - 4. NPS 2: 13 feet with 3/8-inch rod.
- I. Install supports for vertical, Schedule 40, steel piping every 15 feet.

- J. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1/4: 60 inches with 3/8-inch rod.
 2. NPS 3/8 and NPS 1/2: 72 inches with 3/8-inch rod.
 3. NPS 3/4: 84 inches with 3/8-inch rod.
 4. NPS 1: 96 inches with 3/8-inch rod.
 5. NPS 1-1/4: 108 inches with 3/8-inch rod.
 6. NPS 1-1/2: 10 feet with 3/8-inch rod.
 7. NPS 2: 11 feet with 3/8-inch rod.
- K. Install supports for vertical copper tubing every 10 feet.

3.11 LABELING AND IDENTIFICATION

- A. Install identifying labels and devices for general-service compressed-air piping, valves, and specialties. Comply with requirements in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.12 FIELD QUALITY CONTROL

- A. Perform field tests and inspections.
- B. Tests and Inspections:
1. Piping Leak Tests for Metal Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen to pressure of 50 psig above system operating pressure, but not less than 150 psig. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
 2. Repair leaks and retest until no leaks exist.
 3. Inspect filters and pressure regulators for proper operation.
- C. Prepare test reports.

END OF SECTION 22 15 13

SECTION 22 15 19 - GENERAL-SERVICE PACKAGED AIR COMPRESSORS AND RECEIVERS**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Lubricated, reciprocating air compressors.
 - 2. Inlet-air filters.
 - 3. Refrigerant compressed-air dryers.

1.3 DEFINITIONS

- A. Actual Air: Air delivered from air compressors. Flow rate is delivered compressed air measured in acfm.
- B. Standard Air: Free air at 68 deg F and 1 atmosphere before compression or expansion and measured in scfm.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For compressed-air equipment to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Air-Compressor, Inlet-Air-Filter Elements: Equal to 10 percent of amount installed, but no fewer than 2 units.

1.7 FIELD CONDITIONS

- A. Interruption of Existing Compressed-Air Service: Refer to Section 01 12 00 "Multiple Contract Summary" for requirements associated with interrupting the existing compressed-air service to facilities occupied by the Owner.

1.8 COORDINATION

- A. Coordinate size and location of concrete bases with actual equipment provided. Formwork, reinforcement, and concrete requirements are specified in Section 03 30 00 "Cast-in-Place Concrete."

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASME Compliance: Fabricate and label receivers to comply with ASME Boiler and Pressure Vessel Code.

2.2 GENERAL REQUIREMENTS FOR PACKAGED AIR COMPRESSORS AND RECEIVERS

- A. General Description: Factory-assembled, -wired, -piped, and -tested; electric-motor-driven; air-cooled; continuous-duty air compressors and receivers that deliver air of quality equal to intake air.
- B. Control Panels: Automatic control station with load control and protection functions. Comply with NEMA ICS 2 and UL 508.
 - 1. Enclosure: NEMA ICS 6, Type 12 control panel unless otherwise indicated.
 - 2. Motor Controllers: Full-voltage, combination magnetic type with undervoltage release feature and motor-circuit-protector-type disconnecting means and short-circuit protective device.
 - 3. Control Voltage: 120-V ac or less, using integral control power transformer.
 - 4. Motor Overload Protection: Overload relay in each phase.
 - 5. Starting Devices: Hand-off-automatic selector switch in cover of control panel, plus pilot device for automatic control.
 - 6. Instrumentation: Include discharge-air pressure gage, air-filter maintenance indicator, hour meter, compressor discharge-air and coolant temperature gages, and control transformer.

- C. Receivers: Steel tank constructed according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
 - 1. Pressure Rating: At least as high as highest discharge pressure of connected compressors, and bearing appropriate code symbols.
 - 2. Interior Finish: Corrosion-resistant coating.
 - 3. Accessories: Include safety valve, pressure gage, drain, and pressure-reducing valve.
- D. Mounting Frame: Fabricate mounting and attachment to pressure vessel with reinforcement strong enough to resist packaged equipment movement during a seismic event when base is anchored to building structure.

2.3 LUBRICATED, RECIPROCATING AIR COMPRESSORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Quincy Compressor; Model Q13160VQ or comparable product by one of the following:
 - 1. Atlas Copco.
 - 2. Gardner Denver, an Ingersoll Rand business.
 - 3. Ingersoll Rand.
 - 4. Quincy Compressor.
- B. Compressor(s): Lubricated, reciprocating-piston type with lubricated compression chamber and crankcase.
 - 1. Submerged gear-type oil pump.
 - 2. Oil filter.
 - 3. Combined high discharge-air temperature and low lubrication-oil pressure switch.
 - 4. Belt guard totally enclosing pulleys and belts.
- C. Capacities and Characteristics: Refer to Schedule on Drawings.
 - 1. Discharge-Air Pressure: 125 psig.
- D. Receiver: ASME construction steel tank.
 - 1. Interior Finish: Epoxy or galvanized coating.
 - 2. Pressure Rating: 200 psig minimum.
 - 3. Pressure Regulator Setting: 125 psig.

2.4 INLET-AIR FILTERS

- A. Description: Combination inlet-air filter-silencer, suitable for remote installation, for each air compressor.
 - 1. Construction: Weatherproof housing for replaceable, dry-type filter element, with silencer tubes or other method of sound reduction.
 - 2. Capacity: Match capacity of air compressor, with filter having collection efficiency of 99 percent retention of particles larger than 10 micrometers.

- B. Description: Combination inlet-air filter-silencer, suitable for remote installation, for multiple air compressors.
 - 1. Construction: Weatherproof housing for replaceable, dry-type filter element, with silencer tubes or other method of sound reduction.
 - 2. Capacity: Match total capacity of connected air compressors, with filter having collection efficiency of 99 percent retention of particles larger than 10 micrometers.

2.5 REFRIGERANT COMPRESSED-AIR DRYERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Quincy Compressor.; Model QPNC-21 or comparable product by one of the following:
 - 1. Ingersoll Rand
 - 2. Champion Compressor
 - 3. Kaeser Air Compresors
- B. Description: Noncycling, air-cooled, electric-motor-driven unit with steel enclosure and capability to deliver 35 deg F, 100-psig air at dew point. Include automatic ejection of condensate from airstream, step-down transformers, disconnect switches, inlet and outlet pressure gages, thermometers, automatic controls, and filters.
- C. Capacities and Characteristics: Refer to Schedules on Drawings.

2.6 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 22 05 13 "Common Motor Requirements for Plumbing Equipment."
 - 1. Enclosure: Totally enclosed, fan cooled
 - 2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load does not require motor to operate in service factor range above 1.0.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

- A. Equipment Mounting:
 - 1. Install air compressors and air dryers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete"
- B. Install compressed-air equipment anchored to substrate.
- C. Arrange equipment so controls and devices are accessible for servicing.

- D. Maintain manufacturer's recommended clearances for service and maintenance.
- E. Install the following devices on compressed-air equipment:
 - 1. Pressure Regulators: Install downstream from air compressors.
 - 2. Automatic Drain Valves: Install on aftercoolers, receivers, and dryers. Discharge condensate over nearest floor drain.

3.2 CONNECTIONS

- A. Comply with requirements for piping specified in Section 22 15 13 "General-Service Compressed-Air Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to machine, allow space for service and maintenance.

3.3 IDENTIFICATION

- A. Identify general-service air compressors and components. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.4 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Check for lubricating oil in lubricated-type equipment.
 - 3. Check belt drives for proper tension.
 - 4. Verify that air-compressor inlet filters and piping are clear.
 - 5. Check for equipment vibration-control supports and flexible pipe connectors, and verify that equipment is properly attached to substrate.
 - 6. Check safety valves for correct settings. Ensure that settings are higher than air-compressor discharge pressure, but not higher than rating of system components.
 - 7. Drain receiver tanks.
 - 8. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 9. Test and adjust controls and safeties.

3.5 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain air compressors and air dryers.

END OF SECTION 22 15 19

SECTION 22 16 23 - FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipes, tubes, and fittings.
 - 2. Piping and tubing joining materials.
 - 3. Valves.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. An example includes rooftop locations.
- C. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- D. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.

1.4 ACTION SUBMITTALS

- A. Product Data:
 - 1. Piping specialties.
 - 2. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
 - 3. Dielectric fittings.

1.5 CLOSEOUT SUBMITTALS

- A. Field Quality-Control Submittals:
 - 1. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Qualifications:

1. Pipe Welding: Qualify procedures and operators in accordance with the ASME Boiler and Pressure Vessel Code.

B. Regulatory Requirements: Install gas equipment, piping materials and provide testing in accordance with Fuel Gas Code of New York State, applicable American National Standards Institute (ANSI) code and NFPA 54 - National Fuel Gas Code, and rules and regulations of local gas company.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping in accordance with requirements of authorities having jurisdiction.

B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating and protect from direct sunlight.

1.8 PROJECT CONDITIONS

A. Interruption of Existing Natural-Gas Service: Refer to "Existing Utility Interruptions" paragraph of Section 01 12 00 "Multiple Contract Summary-Project Schedule" for requirements associated with interrupting the existing natural gas supply to facilities occupied by the Owner.

1.9 COORDINATION

A. Coordinate requirements for piping identification for natural-gas piping. Comply with requirements in Section 22 05 53 "Identification of Plumbing Piping and Equipment."

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each product type from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Comply with the Fuel Gas Code of New York State.

B. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig minimum unless otherwise indicated.

C. Natural-Gas System Pressure within Buildings:

1. Single Pressure: 0.5 psig or less.

2.3 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A53/A53M, black steel, Schedule 40, Type E or S, Grade B.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - a. Material Group: 1.1.
 - b. End Connections: Threaded or butt welding to match pipe.
 - c. Lapped Face: Not permitted underground.
 - d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
 - e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless-steel underground.
5. Mechanical Couplings:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Dresser Piping Specialties; Division of Dresser, Inc.
 - 2) Smith-Blair, Inc.
 - b. Stainless steel flanges and tube with epoxy finish.
 - c. NBR seals.
 - d. Stainless steel bolts, washers, and nuts.
 - e. Coupling is to be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
 - f. Steel body couplings installed underground on plastic pipe are to be factory equipped with anode.

2.4 JOINING MATERIALS

- A. Joint Compound and Tape: Suitable for natural gas.
- B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.5 MANUAL GAS SHUTOFF VALVES

- A. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
 - 1. CWP Rating: 125 psig.
 - 2. Threaded Ends: Comply with ASME B1.20.1.
 - 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
 - 4. Tamperproof Feature: Locking feature for valves indicated in "Underground, Manual Gas Shutoff Valve Schedule" and "Aboveground, Manual Gas Shutoff Valve Schedule" articles.
 - 5. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
 - 6. Service Mark: Valves NPS 1-1/4 to NPS 2 having initials "WOG" permanently marked on valve body.
- B. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.
 - 1. CWP Rating: 125 psig.
 - 2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
 - 3. Tamperproof Feature: Locking feature for valves indicated in "Underground, Manual Gas Shutoff Valve Schedule" and "Aboveground, Manual Gas Shutoff Valve Schedule" articles.
 - 4. Service Mark: Initials "WOG" permanently marked on valve body.
- C. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide NIBCO INC.; Model T-585-70-UL or comparable product by one of the following:
 - a. BrassCraft Manufacturing Company; a Masco company.
 - b. Conbraco Industries, Inc.; Apollo Div.
 - c. Lyall, R. W. & Company, Inc.
 - d. McDonald, A. Y. Mfg. Co.
 - e. Perfection Corporation; a subsidiary of American Meter Company.
 - 2. Body: Bronze, complying with ASTM B584.

3. Ball: Chrome-plated bronze.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
7. Ends: Threaded, flared, or socket as indicated in "Underground, Manual Gas Shutoff Valve Schedule" and "Aboveground, Manual Gas Shutoff Valve Schedule" articles.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller are to be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

D. Bronze Plug Valves: MSS SP-78.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Lee Brass Company.
 - b. McDonald, A. Y. Mfg. Co.
2. Body: Bronze, complying with ASTM B584.
3. Plug: Bronze.
4. Ends: Threaded, socket, or flanged as indicated in "Underground, Manual Gas Shutoff Valve Schedule" and "Aboveground, Manual Gas Shutoff Valve Schedule" articles.
5. Operator: Square head or lug type with tamperproof feature where indicated.
6. Pressure Class: 125 psig.
7. Listing: Valves NPS 1 and smaller are to be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

E. Cast-Iron, Lubricated Plug Valves: MSS SP-78.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. A.Y. McDonald Mfg. Co.
 - b. Flowserve Corporation.
 - c. Homestead Valve, a division of Olson Technologies, Inc.

- d. Milliken Valve Company; a Mueller brand.
 - e. Mueller Co.
 - f. R & M Energy Systems; Robbins & Myers.
- 2. Body: Cast iron, complying with ASTM A126, Class B.
 - 3. Plug: Bronze or nickel-plated cast iron.
 - 4. Seat: Coated with thermoplastic.
 - 5. Stem Seal: Compatible with natural gas.
 - 6. Ends: Threaded or flanged as indicated in "Underground, Manual Gas Shutoff Valve Schedule" and "Aboveground, Manual Gas Shutoff Valve Schedule" articles.
 - 7. Operator: Square head or lug type with tamperproof feature where indicated.
 - 8. Pressure Class: 125 psig.
 - 9. Listing: Valves NPS 1 and smaller are to be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 - 10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.6 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined. Refer to Section 22 05 00 "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

2.7 LABELING AND IDENTIFYING

- A. Identify system components. Comply with requirements for identification materials and installation in Section 22 05 53 "Identification for Plumbing Piping and Equipment."
- B. Paint: Refer to Section 09 96 00 "High-Performance Coatings" for interior and exterior natural-gas piping paint materials and basic installation requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
- B. Inspect natural-gas piping according to Fuel Gas Code of New York State to determine that natural-gas utilization devices are turned off in piping section affected.
- C. Comply with Fuel Gas Code of New York State requirements for prevention of accidental ignition.

3.3 INSTALLATION OF OUTDOOR PIPING

- A. Comply with Fuel Gas Code of New York State for installation and purging of natural-gas piping.
- B. Install fittings for changes in direction and branch connections.

3.4 INSTALLATION OF INDOOR PIPING

- A. Comply with Fuel Gas Code of New York State for installation and purging of natural-gas piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- D. Do not install piping in concealed locations unless sleeved with the sleeve open at both ends.
- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Where installing piping above accessible ceilings, allow sufficient space for ceiling panel removal.
- G. Locate valves for easy access. Do not locate valves within return air plenums.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Verify final equipment locations for roughing-in.
- K. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

- L. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
 - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- M. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
- N. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
- O. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.
 - 1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
 - 2. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
 - a. Exception: Tubing passing through partitions or walls does not require striker barriers.
 - 3. Prohibited Locations:
 - a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
 - b. Do not install natural-gas piping in solid walls or partitions.
- P. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- Q. Connect branch piping from top or side of horizontal piping.
- R. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
- S. Do not use natural-gas piping as grounding electrode.
- T. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

- U. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."
- V. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

3.5 INSTALLATION OF VALVES

- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.
- B. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
- C. Install anode for metallic valves in underground PE piping.
- D. Do not install valves in return-air plenums.

3.6 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
 - 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
 - 2. Cut threads full and clean using sharp dies.
 - 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
 - 4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
 - 5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. Welded Joints:
 - 1. Construct joints in accordance with AWS D10.12/D10.12M, using qualified processes and welding operators.
 - 2. Bevel plain ends of steel pipe.
 - 3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.
- E. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

3.7 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment" for hangers, supports, and anchor devices.

- B. Install hangers for steel piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- C. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 - 2. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
- D. Support horizontal piping within 12 inches of each fitting.
- E. Support vertical runs of steel piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.8 PIPING CONNECTIONS

- A. Install natural-gas piping electrically continuous and bonded to gas-appliance equipment grounding conductor of the circuit powering the appliance in accordance with NFPA 70.
- B. Where installing piping adjacent to appliances, allow space for service and maintenance of appliances.
- C. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

3.9 LABELING AND IDENTIFICATION

- A. Comply with requirements in Section 22 05 53 "Identification for Plumbing Piping and Equipment" for piping and valve identification.

3.10 PAINTING

- A. Comply with requirements in Section 09 96 00 "High-Performance Coatings" for painting interior and exterior natural-gas piping.
- B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components with factory-applied paint or protective coating.
- C. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components with factory-applied paint or protective coating.
- D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.11 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Test, inspect, and purge natural gas according to Fuel Gas Code of New York State and authorities having jurisdiction.
 - a. Isolate appliances and equipment prior to conducting pressure test.
 - b. The test medium shall be air, nitrogen, carbon dioxide or an inert gas. Oxygen shall not be used.
 - c. Leave pipe joints, including welds, exposed for examination during the test.
 - d. Isolate the source of pressure before the pressure tests are made.
 - e. Measure test pressure with a manometer or with a pressure-measuring device designed and calibrated to read, record or indicate a pressure loss caused by leakage during the pressure test period. Mechanical gauges used to measure test pressures shall have a range such that the highest end of the scale is not greater than five times the test pressure.
 - f. Pressure test piping to no less than 1-1/2 times the proposed maximum working pressure, but not less than 30-psig irrespective of delivered gas pressure, for a duration of 2 hours.

B. Natural-gas piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.12 OUTDOOR PIPING SCHEDULE

A. Aboveground natural-gas piping NPS 2 1/2 and larger shall be the following:

1. ASTM A53 / A53M steel pipe with wrought-steel fittings and welded joints.

3.13 INDOOR PIPING SCHEDULE

A. Aboveground, distribution piping NPS 2 and smaller shall be one of the following:

1. ASTM A53 seamless steel pipe with malleable-iron fittings and threaded joints.
2. ASTM A53 seamless steel pipe with wrought-steel fittings and welded joints.

B. Aboveground, distribution piping NPS 2 1/2 and larger shall be the following:

1. ASTM A53 / A53M steel pipe with wrought-steel fittings and welded joints.

3.14 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Valves for pipe sizes NPS 2 and smaller shall be one of the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
 - 2. Bronze plug valve.
- B. Valves for pipe sizes NPS 2-1/2 and larger shall be the following:
 - 1. Cast-iron, non-lubricated plug valve.

END OF SECTION 22 16 23

SECTION 22 42 13.13 - COMMERCIAL WATER CLOSETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Water closets.
 - 2. Flushometer valves.
 - 3. Toilet seats.

1.3 DEFINITIONS

- A. Effective Flush Volume: Average of two reduced flushes and one full flush per fixture.
- B. WaterSense Fixture: Water closet and/or flushometer valve/tank certified by the EPA to meet the WaterSense performance criteria.

1.4 SUBMITTALS, GENERAL

- A. General: Submit all action submittals required by this Section concurrently.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for water closets. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 1. Water Closet "A" flushometer valves.
 - 2. Water Closet "B" flushometer valves.
 - 3. Transformer for Hard-Wired Flushometer Valves.
- B. As-Specified Data: If the product to be incorporated in the Work is as specified by manufacturer name and product designation in this Specification Section, submit the "**As-Specified Verification Form**" (attached to Section 01 33 00 "Submittal Procedures") for each item listed below; otherwise submit full Product Data for the following:
 - 1. Water Closet "A" bowl.
 - 2. Water Closet "B" bowl.
 - 3. Supports.

4. Toilet seats.
5. Supply fittings.

C. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in operation and maintenance manuals.

1.7 MAINTENANCE MATERIALS

- A. Furnish extra materials that are packaged with protective covering for storage and identified with labels describing contents.
1. Flushometer-Valve Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than six of each type.

1.8 QUALITY ASSURANCE

- A. Water Conservation:
1. Provide plumbing fixtures complying with applicable provisions of Section 604.4 of the Plumbing Code of New York State.
- B. Regulatory Requirements: Comply with requirements in 36 CFR Part 1191 – “Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines”; for plumbing fixtures for people with disabilities.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Standards:
1. Comply with ASME A112.19.2/CSA B45.1 for water closets.
 2. Comply with ASME A112.19.5/CSA B45.15 for flush valves and spuds for water closets and tanks.
 3. Comply with ASSE 1037/ASME A112.1037/CSA B125.37 for flush valves.
 4. Comply with IAMPO/ANSI Z124.5 for water-closet (toilet) seats.
 5. Comply with ASME A112.6.1M for water-closet supports.
 6. Comply with ICC A117.1 for ADA-compliant water closets.
 7. Comply with ASTM A1045 for flexible PVC gaskets used in connection of vitreous china water closets to sanitary drainage systems.
 8. Comply with ASME A112.4.3 for plastic fittings used in connection of vitreous china water closets to sanitary drainage systems.
 9. Comply with ASME A112.18.6 for braided or corrugated stainless-steel flexible hose.

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 GENERAL CHARACTERISTICS

- A. Vitreous China: Unmarked, true and level, clear, smooth and bright. Warranted not to craze, color or scale.
- B. Trap ways no less than 2-1/8 inches in diameter and fully glazed.
- C. Water surface area no less than 10 inches x 12 inches.
- D. 100 percent factory tested for hydraulic performance, and trap seal depth, meeting or exceeding ANSI/ASME Standard A112.19.6, CSA B45 and a minimum ball pass diameter of 2 inches.

2.3 WALL-MOUNTED WATER CLOSETS

- A. Water Closets (WC "A" and "B"): Wall mounted, top spud.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide American Standard; Aftwall Millennium FloWise Elongated No. 3351.101 or comparable product by one of the following:
 - a. Kohler Co.
 - b. Sloan Valve Company.
 - c. Zurn Industries, LLC.
 - 2. Bowl:
 - a. Material: Vitreous china.
 - b. Type: Siphon jet.
 - c. Style: Flushometer valve.
 - d. Height: Refer to Plumbing Fixture Schedule on Drawings.
 - e. Rim Contour: Elongated.
 - f. Water Consumption: 1.1 gal. – 1.6 gal. per flush.
 - g. Effective Flush Volume: 1.28 gal. per flush.
 - h. Spud Size and Location: NPS 1-1/2; top.
 - i. Outlet: Back.
 - j. Color: White.
 - 3. Support: Comply with requirements in "Support" Article.
 - 4. Flushometer Valve: Hard-Wired Flushometer Valves. Comply with requirements in "Flushometer Valve" Article.
 - 5. Toilet Seat: Standard Toilet Seat. Comply with requirements in "Toilet Seat" Article.

2.4 FLUSHOMETER VALVES

A. Hard-Wired Flushometer Valves:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Sloan Valve Company; Sloan Sensor Model No. 111 ESS-1.28-HW-TMO-YO-DFB-OR-TP-HW or comparable product by the following:
 - a. Zurn Industries, LLC; Commercial Brass and Fixtures.
2. Minimum Pressure Rating: 125 psig.
3. Features: Include angle stop bumper, sweat solder adapter, cast set screw escutcheon, casing tube, integral check stop and backflow-prevention device.
4. Material: Brass body with corrosion and chloramine resistant components.
5. Exposed Flushometer-Valve Finish: Chrome plated.
6. Actuator: Solenoid complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
7. Trip Mechanism: Hard-wired electronic sensor complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application. Includes a courtesy flush, non-hold-open true mechanical override.
8. Consumption: 1.28 gal. per flush.
9. Minimum Inlet: NPS 1.
10. Minimum Outlet: NPS 1-1/4.
11. Provide 4" x 4" x 2-1/2" electric boxes as required by manufacturer for each hard wired flushometer.
12. Provide control wiring between flushometer solenoid valve, sensor, and transformer.

B. Transformer for Hard-Wired Flushometer Valves:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Sloan Valve Company; Model No. EL-154 or comparable product by the following:
 - a. Zurn Industries, LLC; Commercial Brass and Fixtures.
2. Standard: Class II, UL Listed.
3. Features: Box-mount transformer designed for use with hard-wired flushometer valves. Operates up to 10 flushometer valves.
4. Input: 120 VAC.

5. Output: 24 VAC.
6. Volt amperes: 50.

2.5 TOILET SEATS

A. Standards Toilet Seats:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard.
 - b. Bemis Manufacturing Company.
 - c. Church Seats; Bemis Manufacturing Company.
 - d. Kohler Co.
 - e. ProFlo; a Ferguson Enterprises, Inc. brand.
 - f. Zurn Industries, LLC.
2. Material: Anti-microbial treated fire-retardant plastic.
3. Type: Commercial (Heavy duty).
4. Shape: Elongated rim, open front.
5. Hinge: Self-sustaining, check.
6. Hinge Material: Stainless steel.
7. Seat Cover: Not required.
8. Color: White.

2.6 SUPPORTS

A. Water Closet Carrier:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith Mfg.; Series 100 and Series 200 M51 or comparable product by one of the following:
 - a. Josam Company.
 - b. Zurn Industries, LLC.
2. Description: Waste-fitting assembly, as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture.
 - a. Provide horizontal carrier fittings with NPS 2 auxiliary no-hub inlet where appropriate for other plumbing fixture vertical pipe connections.
 - 1) Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith Mfg.; Series 209 and Series 219 M51 or comparable product.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before water-closet installation.
- B. Examine walls and floors for suitable conditions where water closets will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.
- D. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 INSTALLATION

A. Water-Closet Installation:

- 1. Install level and plumb according to roughing-in drawings.
- 2. Install accessible, wall-mounted water closets at mounting height for handicapped/elderly, according to ICC/ANSI A117.1.

B. Support Installation:

- 1. Install supports, affixed to building substrate, for floor-mounted, back-outlet water closets.
- 2. Use carrier supports with waste-fitting assembly and seal.
- 3. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals; and affix to building substrate.
- 4. Measure support height installation from finished floor, not structural floor.

C. Flushometer-Valve Installation:

- 1. Install flushometer-valve, water-supply fitting on each supply to each water closet.
- 2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
- 3. Install flushometer valves for accessible water closets such that the operating handle faces the approach or transfer side of the water closet stall. Install sensor operated flushometer valves in the same manner so that, in the event that the sensor operated flushometer valve is replaced by a manually operated valve, the handle will comply with the above requirement.
- 4. Provide 4" x 4" x 2-1/2" electric boxes as required by manufacturer for each hard wired flushometer.
- 5. Provide control wiring between flushometer solenoid valve, sensor, and transformer.

D. Install toilet seats on water closets.

E. Wall Flange and Escutcheon Installation:

- 1. Comply with escutcheon requirements specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

2. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
3. Install escutcheon so set screw is facing floor.

F. Joint Sealing:

1. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."
2. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
3. Match sealant color to water-closet color.

3.3 PIPING CONNECTIONS

- A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.
- B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."
- D. Where installing piping adjacent to water closets, allow space for service and maintenance.

3.4 ELECTRICAL CONNECTIONS

- A. Install control wiring to field-mounted control devices.
- B. Connect control wiring in accordance with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- C. Ground equipment in accordance with Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- D. Install electrical devices furnished by manufacturer, but not factory mounted in accordance with NFPA 70 and NECA 1.
- E. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
 1. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.5 ADJUSTING

- A. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.
- B. Adjust water pressure at flushometer valves to produce proper flow.

3.6 CLEANING AND PROTECTION

- A. Clean water closets and fittings with manufacturers' recommended cleaning methods and materials.
- B. Install protective covering for installed water closets and fittings.

END OF SECTION 22 42 13.13

SECTION 22 42 13.16 - COMMERCIAL URINALS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Urinals.
 - 2. Flushometer valves.
 - 3. Supports.

1.3 SUBMITTALS, GENERAL

- A. General: Submit all action submittals required by this Section concurrently.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for urinals. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 1. Urinal "A" flushometer valves.
- B. As-Specified Data: If the product to be incorporated in the Work is as specified by manufacturer name and product designation in this Specification Section, submit the "**As-Specified Verification Form**" (attached to Section 01 33 00 "Submittal Procedures") for each item listed below; otherwise submit full Product Data for the following:
 - 1. Urinal "A" bowls.
 - 2. Support.
- C. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in operation and maintenance manuals.

1.6 MAINTENANCE MATERIALS

- A. Furnish extra materials that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Flushometer-Valve Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than one of each type.

1.7 QUALITY ASSURANCE

- A. Water Conservation:
 - 1. Provide plumbing fixtures complying with applicable provisions of Section 604.4 of the Plumbing Code of New York State.
- B. Regulatory Requirements: Comply with requirements in 36 CFR Part 1191 – “Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines”; for plumbing fixtures for people with disabilities.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 WALL-HUNG URINALS

- A. Urinals (UR “A”): Top spud.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide American Standard America; Washbrook FloWise No. 6590.001 or comparable product by one of the following:
 - a. Kohler Co.; Dexter Model K-5016-ET.
 - b. Sloan Valve Company.; Model SU-1009.
 - c. Zurn Industries, LLC.; OMNI-FLO Model Z5755-U.
 - 2. Fixture:
 - a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5/CSA B45.15.
 - b. Material: Vitreous china.
 - c. Type: Washout flush action with extended shields.
 - d. Strainer or Trapway: Manufacturer's standard strainer with integral trap.
 - e. Water Consumption: 0.5 gal. per flush.
 - f. Spud Size and Location: NPS 3/4; top.
 - g. Outlet Size and Location: NPS 2; back.
 - h. Color: White.

3. Waste Fitting:
 - a. Standard: ASME A112.18.2/CSA B125.2 for coupling.
 - b. Size: NPS 2.
4. Flushometer Valve: Hard-Wired Flushometer Valves. Comply with requirements in “Flushometer Valve” Article.
5. Support: Comply with requirements in “Support” Article.

2.3 FLUSHOMETER VALVES

A. Hard-Wired Flushometer Valves:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Sloan Valve Company; Sloan Sensor Model No. 186 ESS-0.5-DFB-OR-HW or comparable product by the following:
 - a. Zurn Industries, LLC.
2. Standard: ASSE 1037.
3. Minimum Pressure Rating: 125 psig.
4. Features: Include sweat solder adapter, cast set screw escutcheon, casing tube, integral check stop and backflow-prevention device.
5. Material: Brass body with corrosion and chloramine resistant components.
6. Exposed Flushometer-Valve Finish: Chrome plated.
7. Style: Exposed.
8. Actuator: Solenoid complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
9. Trip Mechanism: Hard-wired electronic sensor complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
10. Consumption: 0.5 gal. (1.9 L per flush.
11. Minimum Inlet: NPS 3/4.
12. Minimum Outlet: NPS 3/4.
13. Provide 4" x 4" x 2-1/2" electric boxes as required by manufacturer for each hard wired flushometer.
14. Provide control wiring between flushometer solenoid valve, sensor, and transformer.

B. Transformer for Hard-Wired Flushometer Valves:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Sloan Valve Company; Model No. EL-154 or comparable product by the following:
 - a. Zurn Industries, LLC; Commercial Brass and Fixtures.
2. Standard: Class II, UL Listed.
3. Features: Box-mount transformer designed for use with hard-wired flushometer valves. Operates up to 10 flushometer valves.
4. Input: 120 VAC.
5. Output: 24 VAC.
6. Volt amperes: 50.

2.4 SUPPORTS

A. Type I Urinal Carrier:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith Mfg Co; a division of Morris Group International; Series 637 or a comparable product by one of the following:
 - a. Josam Company.
 - b. MIFAB, Inc.
 - c. Wade Drains.
 - d. WATTS.
 - e. Zurn Industries, LLC.
2. Standard: ASME A112.6.1M.
3. Description: Type I, urinal carrier with top and bottom fixture support plates, coupling with seal and fixture bolts and hardware matching fixture, 1-1/4 inch diameter steel uprights welded to 4 inch square steel floor anchor plates.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before urinal installation.
- B. Examine walls and floors for suitable conditions where urinals will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.
- D. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 INSTALLATION

A. Urinal Installation:

1. Install urinals level and plumb according to roughing-in drawings.
2. Install wall-hung, back-outlet urinals onto waste fitting seals and attached to supports.
3. Install accessible, wall-mounted urinals at mounting height for the handicapped/elderly, according to ICC/ANSI A117.1.

B. Support Installation:

1. Install supports, affixed to building substrate, for wall-hung urinals.
2. Use off-floor carriers with waste fitting and seal for back-outlet urinals.
3. Use chair-type carrier supports with rectangular steel uprights for accessible urinals.
4. Measure support height installation from finished floor, not structural floor.

C. Flushometer-Valve Installation:

1. Install flushometer-valve water-supply fitting on each supply to each urinal.
2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.

D. Wall Flange and Escutcheon Installation:

1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations.
2. Install deep-pattern escutcheons if required to conceal protruding fittings.
3. Comply with escutcheon requirements specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

E. Joint Sealing:

1. Seal joints between urinals and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to urinal color.
3. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."

3.3 PIPING CONNECTIONS

- A. Connect urinals with water supplies and soil, waste, and vent piping. Use size fittings required to match urinals.
- B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."
- D. Where installing piping adjacent to urinals, allow space for service and maintenance.

3.4 ELECTRICAL CONNECTIONS

- A. Install control wiring to field-mounted control devices.

- B. Connect control wiring in accordance with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- C. Ground equipment in accordance with Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- D. Install electrical devices furnished by manufacturer, but not factory mounted in accordance with NFPA 70 and NECA 1.
- E. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
 - 1. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.5 ADJUSTING

- A. Operate and adjust urinals and controls. Replace damaged and malfunctioning urinals, fittings, and controls.
- B. Adjust water pressure at flushometer valves to produce proper flow.
- C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.6 CLEANING AND PROTECTION

- A. Clean urinals and fittings with manufacturers' recommended cleaning methods and materials.
- B. Install protective covering for installed urinals and fittings.
- C. Do not allow use of urinals for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 42 13.16

SECTION 22 42 16.13 - COMMERCIAL LAVATORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Lavatories.
2. Faucets.
3. Supplies.
4. Drains.
5. Traps.
6. Supports.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for lavatories. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1. Lavatory "A" faucets.
2. Lavatory "B" faucets.

- B. As-Specified Data: If the product to be incorporated in the Work is as specified by manufacturer name and product designation in this Specification Section, submit the "**As-Specified Verification Form**" (attached to Section 01 33 00 "Submittal Procedures") for each item listed below; otherwise submit full Product Data for the following:

1. Lavatory "A" bowls.
2. Lavatory "B" bowls.
3. Supports.
4. Supply fittings.
5. Straight tailpiece drains.
6. Offset tailpiece drains.
7. Standard traps.

- C. Samples for Verification and Color Selection: Full range of manufacturer's actual solid surface color sample tiles for products involving color selection. Color samples on paper will not be accepted.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For lavatories and faucets to include in operation and maintenance manuals.

1.4 MAINTENANCE MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

1.5 QUALITY ASSURANCE

- A. Water Conservation:
 - 1. Provide plumbing fixtures complying with applicable provisions of Section 604.4 of the Plumbing Code of New York State.
- B. Regulatory Requirements: Comply with requirements in 36 CFR Part 1191 – “Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines”; for plumbing fixtures for people with disabilities.

1.6 FIELD CONDITIONS

- A. Comply with “Project/Site Conditions” article in Part 1 of Section 22 05 00 “Common Work Results for Plumbing” for lead testing requirements prior to commencing any work.
- B. Coordinate potable water lead testing with Owner prior to starting any construction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Lavatory faucets intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 VITREOUS-CHINA, WALL-MOUNTED LAVATORIES

- A. Lavatory (LAV “A”): Vitreous china, wall mounted, accessible with back.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide American Standard America; Lucerne No. 0355.012 or comparable product by one of the following:
 - a. Kohler Co.
 - b. Sloan Valve Company.
 - c. Zurn Industries, LLC.

2. Fixture:
 - a. Standard: ASME A112.19.2/CSA B45.1.
 - b. Type: For wall hanging.
 - c. Nominal Size: Rectangular, 20 by 18 inches.
 - d. Faucet-Hole Punching: Three holes, 4-inch centers.
 - e. Faucet-Hole Location: Top.
 - f. Color: White.
 - g. Mounting Material: Chair carrier.
 3. Faucet: Manual-type, two-handle metering, centerset commercial, solid-brass valve. Comply with requirements in "Lavatory Faucet" Article.
 4. Water-Temperature Limiting Device: Comply with requirements for temperature-actuated, water mixing valves specified in Section 22 11 19 "Domestic Water Piping Specialties" and as scheduled on Drawings.
 5. Supplies: Comply with requirements in "Supply Fittings" Article.
 6. Drain: Straight Tailpiece. Comply with requirements in "Drain" Article.
 7. Trap: Standard Trap. Comply with requirements in "Trap" Article.
 8. Support: Comply with requirements in "Support" Article.
- B. Lavatory (LAV "A"): Vitreous china, wall mounted, accessible with back.
1. Basis-of-Design Product: Subject to compliance with requirements, provide American Standard America; Lucerne No. 0355.012 or comparable product by one of the following:
 - a. Kohler Co.
 - b. Sloan Valve Company.
 - c. Zurn Industries, LLC.
 2. Fixture:
 - a. Standard: ASME A112.19.2/CSA B45.1.
 - b. Type: For wall hanging.
 - c. Nominal Size: Rectangular, 20 by 18 inches.
 - d. Faucet-Hole Punching: Three holes, 4-inch centers.
 - e. Faucet-Hole Location: Top.
 - f. Color: White.
 - g. Mounting Material: Chair carrier.
 3. Faucet: Manual-type, two-handle metering, centerset commercial, solid-brass valve. Comply with requirements in "Lavatory Faucet" Article.
 4. Water-Temperature Limiting Device: Comply with requirements for temperature-actuated, water mixing valves specified in Section 22 11 19 "Domestic Water Piping Specialties" and as scheduled on Drawings.

5. Supplies: Comply with requirements in “Supply Fittings” Article.
6. Drain: Offset Tailpiece. Comply with requirements in “Drain” Article.
7. Trap: Standard Trap. Comply with requirements in “Trap” Article.
8. Support: Comply with requirements in “Support” Article.

2.3 MANUALLY OPERATED LAVATORY FAUCETS

- A. Lavatory faucets intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), with requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61/NSF 372, or be certified in compliance with NSF 61/NSF 372 by an American National Standards Institute (ANSI) accredited third-party certification body, that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.
- B. Lavatory Faucets: Manual-type, two-handle metering, centerset commercial, solid-brass valve.
 1. Basis-of-Design Product: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Chicago Faucets; MVP Commercial Faucet No. 802-V665CP.
 - b. Delta Faucet Company; Commercial Faucet No. 86T1153.
MOEN M-PRESS COMMERCIAL FAUCET NO. 8886.
 - c. Zurn Industries, LLC; Commercial Brass and Fixtures; AquaSpec Faucet No. Z86500.
 2. Standard: ASME A112.18.1/CSA B125.1.
 3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
 4. Body Type: Centerset, with 4” centers.
 5. Body Material: Commercial, solid brass.
 6. Finish: Polished chrome plate.
 7. Maximum Flow: 0.25 gal. per metering cycle.
 8. Mounting Type: Deck, exposed.
 9. Valve Handle(s): Push button.
 10. Spout: Rigid type.
 11. Spout Outlet: Aerator.
 12. Operation: Compression, manual.

2.4 SUPPLY FITTINGS

- A. NSF Standard: Comply with NSF 61 and NSF 372 for supply-fitting materials that will be in contact with potable water.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide McGuire Manufacturing, Inc., or comparable product by one of the following:
 - 1. American Standard America.
 - 2. Zurn Industries, LLC; Commercial Brass and Fixtures.
- C. Standard: ASME A112.18.1/CSA B125.1.
- D. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated brass escutcheon with set screw.
- E. Supply Stops: Basis-of-Design: No. LFHST02LKSB chrome-plated-brass, compression valve with inlet connection matching supply piping.
 - 1. Operation: Loose key.
- F. Risers: ASME A112.18.6/CSA B125.6, braided-stainless steel, flexible hose riser.
 - 1. NPS 3/8.

2.5 DRAINS

- A. Straight Tailpiece:
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide McGuire Manufacturing, Inc.; No. 155-A or comparable product by one of the following:
 - a. American Standard America.
 - b. Zurn Industries, LLC; Commercial Brass and Fixtures.
- B. Offset Tailpiece:
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide McGuire Manufacturing, Inc.; No. 155-WC or comparable product by one of the following:
 - a. American Standard America
 - b. Zurn Industries, LLC; Commercial Brass and Fixtures.
- C. Standard: ASME A112.18.2/CSA B125.2.
- D. Drain: Grid type with NPS 1-1/4 tailpiece.
- E. Material: Seamless, chrome plated cast brass, brass locknut, heavy rubber basin washer and fiber friction washer.

2.6 TRAPS

A. Standard Trap:

1. Basis-of-Design Product: Subject to compliance with requirements, provide McGuire Manufacturing, Inc.; No. 8902-F or comparable product by one of the following:
 - a. American Standard America.
 - b. Zurn Industries, LLC; Commercial Brass and Fixtures.
2. Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow, 17 gauge brass tube to wall with cleanout plug. Include chrome-plated brass escutcheon with set screw.

B. Standard: ASME A112.18.2/CSA B125.2.

C. Size: NPS 1-1/2 by NPS 1-1/4.

2.7 LAVATORY SUPPORTS

A. Lavatory Carrier:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith Mfg Co; a division of Morris Group International; Series No. 700-M31 or a comparable product by one of the following:
 - a. MIFAB, Inc.
 - b. WATTS; A Watts Water Technologies Company.
 - c. Zurn Industries, LLC.
2. Standard: ASME A112.6.1M.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before lavatory installation.
- B. Examine counters and walls for suitable conditions where lavatories will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.
- D. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 INSTALLATION

- A. Install lavatories level and plumb in accordance with roughing-in drawings.
- B. Install supports, affixed to building substrate, for wall-mounted lavatories.
- C. Measure support height installation from finished floor, not structural floor.

- D. Install water-supply piping with stop on each supply to each lavatory faucet. Install stops in locations that are accessible for ease of operation.
- E. Install trap and waste piping on each drain outlet of each lavatory to be connected to sanitary drainage system.
- F. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, in accordance with ICC A117.1.
- G. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 22 05 18 "Escutcheons for Plumbing Piping."
- H. Seal joints between lavatories, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."
- I. Install protective shielding enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 22 07 19 "Plumbing Piping Insulation."

3.3 PIPING CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

3.4 FIELD QUALITY CONTROL

- A. Comply with "Field Quality Control" article in Part 3 of Section 22 05 00 "Common Work Results for Plumbing" for lead testing requirements prior to commencing any work.
- B. Inspecting Agency: Engage a qualified laboratory to perform lead testing on all potable water faucets installed under this contract and used or potentially used for drinking or cooking purposes according to NYS Law 10 CRR-NY 67-4.1. Submit test results Owner and the Architect.
- C. Replace any faucet that exceeds the lead action level (5 micrograms per liter) and coordinate with the Owner for retesting until satisfactory results are obtained.

3.5 ADJUSTING

- A. Operate and adjust lavatories and controls. Replace damaged and malfunctioning lavatories, fittings, and controls.

3.6 CLEANING AND PROTECTION

- A. After completing installation of lavatories, inspect and repair damaged finishes.
- B. Clean lavatories, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed lavatories and fittings.

END OF SECTION 22 42 16.13

SECTION 22 42 16.16 - COMMERCIAL SINKS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Service basins.
2. Sinks.
3. Sink faucets.
4. Supply fittings.
5. Waste fittings.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for sinks. Include rated capacities, operating characteristics and furnished specialties and accessories.
 - a. Mop receptor faucet.
 - b. Sink "A" faucet.
 - c. Sink "B" faucet.
 - d. Sink "C" faucet.
 - e. Sink "D" faucet.
 - f. Sink "E" faucet.
 - g. Sink "F" faucet.
 - h. Sink "G" faucet.

- B. As-Specified Data: If the product to be incorporated in the Work is as specified by manufacturer name and product designation in this Specification Section, submit the "**As-Specified Verification Form**" (attached to Section 01 33 00 "Submittal Procedures") for each item listed below; otherwise submit full Product Data for the following:

1. Mop receptor "A".
2. Mop receptor accessories.
3. Sink "A" bowl.
4. Sink "B" bowl.
5. Sink "C" bowl.
6. Sink "D" bowl.

7. Sink "G" bowl.
8. Supply Fittings.
9. Drain Fitting.
10. Offset Drain Fitting.
11. Dishwasher Tailpiece.
12. Continuous Waste Fittings.
13. Sink Traps.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted sinks.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For sinks and accessories to include in maintenance manuals.

1.6 MAINTENANCE MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.
 2. Science Faucet Outlets: Full flow serrated nozzles equal to 75 percent of amount of each type and size science faucet installed.

1.7 QUALITY ASSURANCE

- A. Water Conservation:
 1. Provide plumbing fixtures complying with applicable provisions of Section 604.4 of the Plumbing Code of New York State, including the 2017 Uniform Code Supplement.
- B. Regulatory Requirements: Comply with requirements in 36 CFR Part 1191 – "Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines"; for plumbing fixtures for people with disabilities.

1.8 FIELD CONDITIONS

- A. Comply with "Project/Site Conditions" article in Part 1 of Section 22 05 00 "Common Work Results for Plumbing" for lead testing requirements prior to commencing any work.
- B. Coordinate potable water lead testing with Owner prior to starting any construction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Sink faucets intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 SERVICE BASINS

- A. Mop Receptor (MR "A"): Plastic, floor mounted.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Crane Plumbing, L.L.C.; Fiat Model No. MSB2424 or comparable product by one of the following:
 - a. Ferguson Enterprises, Inc.; ProFlo Brand.
 - b. Florestone Products Co., Inc.
 - c. Mustee, E. L., & Sons, Inc.
 - d. Swan Corporation (The).
 - e. Zurn Industries, LLC; Light Commercial Specialty Plumbing Products.
 - 2. Fixture:
 - a. Standard: CSA B45.5/IAPMO Z124.
 - b. Material: Molded polymer.
 - c. Nominal Size: 24 by 24 by 10 inches.
 - d. Tiling Flange: On two sides.
 - e. Rim Guard: On front top surfaces.
 - f. Drain: Stainless steel, flat grid drain body with NPS 3 outlet.
 - 3. Mounting: On floor and flush to wall.
- B. Accessories:
 - 1. Faucet: Comply with requirements in "Sink Faucet" Article.
 - 2. Hose and hose bracket; 5 by 3 inches stainless steel bracket with rubber grips. 30 inch long flexible heavy duty 5/8 inch rubber hose, cloth reinforced with 3/4 inch chrome coupling at one end. Similar to "No. 832-AA" by Fiat.
 - 3. Mop hanger bracket; 24 by 3 inches, stainless steel with three (3) rubber grips. Similar to "No. 889-CC."

2.3 SINKS

A. Sink "A": Standard stainless steel, counter mounted, accessible.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Elkay Manufacturing Co; Model No. LRAD 2219-55 or comparable product by one of the following:
 - a. Advance Tabco.
 - b. Eagle Group; Foodservice Equipment Division.
 - c. Griffin Products, Inc.
 - d. Just Manufacturing.
2. Fixture:
 - a. Standard: ASME A112.19.3/CSA B45.4.
 - b. Type: Ledge back.
 - c. Number of Compartments: One.
 - d. Overall Dimensions: 22 by 19.5 inches.
 - e. Metal Thickness: 18 gauge / 0.050 inch.
 - f. Material: Type 304 stainless steel with fully undercoated underside.
 - g. Compartment:
 - 1) Dimensions: 18 by 14 by 5.5 inches.
 - 2) Drain: 3.5 inch opening.
 - 3) Drain Location: Centered, near back of compartment.
3. Faucet(s): Accessible manual type, single-control mixing valve with swing spout. Comply with requirements in "Sink Faucet" Article.
 - a. Number Required: One.
 - b. Mounting: On sink fixture ledge, in hole(s) provided.
4. Supply Fittings: Comply with requirements in "Supply Fittings" Article.
5. Waste Fittings: Offset Drain Fitting. Comply with requirements in "Drains" Article.
6. Traps: Sink Trap. Comply with requirements in "Traps" Article.
7. Mounting: On counter with manufacturer recommended sealant.

B. Sink "B": Stainless steel, counter mounted, accessible.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Elkay Manufacturing Co; Model No. LRAD 2521-55 or comparable product by one of the following:

- a. Advance Tabco.
 - b. Eagle Group; Foodservice Equipment Division.
 - c. Griffin Products, Inc.
 - d. Just Manufacturing.
2. Fixture:
- a. Standard: ASME A112.19.3/CSA B45.4.
 - b. Type: Ledge back.
 - c. Number of Compartments: One.
 - d. Overall Dimensions: 25 by 21.25 inches.
 - e. Metal Thickness: 18 gauge / 0.050 inch.
 - f. Material: Type 304 stainless steel with fully undercoated underside.
 - g. Compartment:
 - 1) Dimensions: 21 by 15.75 by 5.5 inches.
 - 2) Drain: 3.5 inch opening.
 - 3) Drain Location: Centered, near back of compartment.
3. Faucet(s): Accessible Handwash Sink Faucet, manual type wrist blade handles with rigid gooseneck spout. Comply with requirements in "Sink Faucet" Article.
- a. Number Required: One.
 - b. Mounting: On sink fixture ledge, in hole(s) provided.
4. Supply Fittings: Comply with requirements in "Supply Fittings" Article.
5. Waste Fittings: Offset Drain Fitting. Comply with requirements in "Drains" Article.
6. Traps: Sink Trap. Comply with requirements in "Traps" Article.
7. Mounting: On counter with manufacturer recommended sealant.
- C. Sink "C": Stainless steel, counter mounted, double bowl, accessible.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Elkay Manufacturing Co; Model No. LRAD 3321-55 or comparable product by one of the following:
- a. Advance Tabco.
 - b. Eagle Group; Foodservice Equipment Division.
 - c. Griffin Products, Inc.
 - d. Just Manufacturing.

2. Fixture:
 - a. Standard: ASME A112.19.3/CSA B45.4.
 - b. Type: Ledge back.
 - c. Number of Compartments: Two.
 - d. Overall Dimensions: 33 by 21.25 inches.
 - e. Metal Thickness: 18 gauge / 0.050 inch.
 - f. Material: Type 304 stainless steel with fully undercoated underside.
 - g. Each Compartment:
 - 1) Dimensions: 13.5 by 16 by 5.5 inches.
 - 2) Drain: 3.5 inch openings.
 - 3) Drain Location: Centered, near back of compartments.
 3. Faucet(s): Accessible manual type, single-control mixing valve with swing spout. Comply with requirements in "Sink Faucet" Article.
 - a. Number Required: One.
 - b. Mounting: On sink fixture ledge, in hole(s) provided.
 4. Supply Fittings: Comply with requirements in "Supply Fittings" Article.
 5. Waste Fittings: Offset Drain Fittings and Continuous Waste Fitting. Comply with requirements in "Drains" Article.
 6. Traps: Sink Trap. Comply with requirements in "Traps" Article.
 7. Mounting: On counter with manufacturer recommended sealant.
- D. Sink "D": Stainless steel, counter mounted, double bowl.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Elkay Manufacturing Co; Model No. LR 3321 or comparable product by one of the following:
 - a. Advance Tabco.
 - b. Eagle Group; Foodservice Equipment Division.
 - c. Griffin Products, Inc.
 - d. Just Manufacturing.
 2. Fixture:
 - a. Standard: ASME A112.19.3/CSA B45.4.
 - b. Type: Ledge back.
 - c. Number of Compartments: Two.

- d. Overall Dimensions: 33 by 21.25 inches.
- e. Metal Thickness: 18 gauge / 0.050 inch.
- f. Material: Type 304 stainless steel with fully undercoated underside.
- g. Each Compartment:
 - 1) Dimensions: 28 by 16 by 7.875 inches.
 - 2) Drain: 3.5 inch openings.
 - 3) Drain Location: Centered.
- 3. Faucet(s): Accessible manual type, single-control mixing valve with swing spout. Comply with requirements in "Sink Faucet" Article.
 - a. Number Required: One.
 - b. Mounting: On sink fixture ledge, in hole(s) provided.
- 4. Supply Fittings: Comply with requirements in "Supply Fittings" Article.
- 5. Waste Fittings: Drain Fittings and Continuous Waste Fitting. Comply with requirements in "Drains" Article.
- 6. Traps: Sink Trap. Comply with requirements in "Traps" Article.
- 7. Mounting: On counter with manufacturer recommended sealant.
- E. Sink "E": Accessible science sink with single hole, wrist-blade-handle faucet.
 - 1. Fixture: Refer to Specification Section 12 32 13 "Manufactured Wood-Veneer-Faced Casework" for science sink bowls.
 - 2. Faucet(s): Accessible, manual type, single hole, wrist-blade-handle mixing valve science sink faucet. Comply with requirements in "Sink Faucet" Article.
 - a. Number Required: One.
 - b. Mounting: On countertop, in hole provided.
 - 3. Supply Fittings: Comply with requirements in "Supply Fittings" Article.
 - 4. Waste Fittings: PP Sink Outlets. Comply with requirements for chemical resistant waste fittings specified in Section 22 66 00 "Chemical-Waste Systems for Laboratory Facilities."
 - 5. Traps: Corrosion-Resistant Traps. Comply with requirements for chemical resistant traps specified in Section 22 66 00 "Chemical-Waste Systems for Laboratory Facilities."
- F. Sink "F": Science sink with single hole, two-cross-handle faucet.
 - 1. Fixture: Refer to Specification Section 12 32 13 "Manufactured Wood-Veneer-Faced Casework" for science sink bowls.

2. Faucet(s): Manual type, single hole, two-cross-handle mixing valve science sink faucet. Comply with requirements in "Sink Faucet" Article.
 - a. Number Required: One.
 - b. Mounting: On countertop, in hole provided.
3. Supply Fittings: Comply with requirements in "Supply Fittings" Article.
4. Waste Fittings: PP Sink Outlets. Comply with requirements for chemical resistant waste fittings specified in Section 22 66 00 "Chemical-Waste Systems for Laboratory Facilities."
5. Traps: Corrosion-Resistant Traps. Comply with requirements for chemical resistant traps specified in Section 22 66 00 "Chemical-Waste Systems for Laboratory Facilities."

G. Sink "G": Plastic laundry tub, freestanding.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Crane Plumbing, L.L.C.; Fiat Model No. FL-1 Floor Mounted Serv-A-Sink or comparable product by one of the following:
 - a. Ferguson Enterprises, Inc.; ProFlo Brand.
 - b. Florestone Products Co., Inc.
 - c. Mustee, E. L., & Sons, Inc.
 - d. Swan Corporation (The).
 - e. Zurn Industries, LLC; Light Commercial Specialty Plumbing Products.
2. Fixture:
 - a. Standard: CSA B45.5/IAPMO Z124.
 - b. Material: Molded polymer.
 - c. Nominal Size: 23 by 21-1/2 by 13-7/16 inches.
 - d. Color: White.
3. Supports: Adjustable-length steel legs.
4. Faucet(s): Manual type, center set deck faucet with arc tube spout. Comply with requirements in "Sink Faucet" Article.
 - a. Number Required: One.
 - b. Mounting: On backsplash.
5. Supply Fittings: Comply with requirements in "Supply Fittings" Article.
6. Waste Fittings: 1-1/2 inch drain assembly provided with sink by the manufacturer.
7. Traps: Sink Trap. Comply with requirements in "Traps" Article.

2.4 SINK FAUCETS

- A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for faucet-spout materials that will be in contact with potable water.

B. Mop Receptor Faucets: Manual type, two-lever-handle mixing valve.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Speakman Company: Model No. SC-5811 or comparable product by one of the following:
 - a. Chicago Faucets.
 - b. Delta Faucet Company.
 - c. GROHE America, Inc.
 - d. Just Manufacturing.
 - e. Moen Incorporated.
 - f. T & S Brass and Bronze Works, Inc.
 - g. Zurn Plumbing Products Group.
2. Standard: CSA/ASSE-1001.
3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.
4. Body Type: Widespread.
5. Body Material: Commercial, solid brass.
6. Finish: Polished chrome plate.
7. Maximum Flow Rate: 10 gpm hot- and cold-water full open at 40 psig
8. Handle(s): Cross, four arm.
9. Mounting Type: Back/wall, exposed.
10. Spout Type: Rigid, solid brass with wall brace.
11. Vacuum Breaker: Required for hose outlet.
12. Spout Outlet: Hose thread according to ASME B1.20.7.
13. Integral Stops: Required.

C. Sink Faucets: Accessible manual type, single-control mixing valve with swing spout.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Elkay Manufacturing Co; Model LK1000CR or comparable product by one of the following:
 - a. American Standard America.
 - b. Bradley Corporation.
 - c. Chicago Faucets.
 - d. Delta Faucet Company.
 - e. Elkay Manufacturing Co.
 - f. GROHE America, Inc.
 - g. Just Manufacturing.
 - h. Kohler Co.
 - i. Moen Incorporated.

- j. Speakman Company.
 - k. T & S Brass and Bronze Works, Inc.
 - l. Zurn Industries, LLC; Commercial Brass and Fixtures.
 - 2. Standard: ASME A112.18.1/CSA B125.1.
 - 3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.
 - 4. Body Type: Widespread.
 - 5. Body Material: General-duty, solid brass.
 - 6. Finish: Chrome plated.
 - 7. Maximum Flow Rate: 1.5 gpm.
 - 8. Handle(s): Lever.
 - 9. Mounting Type: Deck, exposed.
 - 10. Spout Type: Swing, shaped tube.
 - 11. Spout Outlet: Aerator.
- D. Sink Faucets: Manual type, center set deck faucet with arc tube spout.
- 1. Basis-of-Design Product: Subject to compliance with requirements, provide Elkay Manufacturing Co; Model LK406AT10L2 or comparable product by one of the following:
 - a. American Standard America.
 - b. Bradley Corporation.
 - c. Chicago Faucets.
 - d. Delta Faucet Company.
 - e. GROHE America, Inc.
 - f. Just Manufacturing.
 - g. Kohler Co.
 - h. Moen Incorporated.
 - i. Speakman Company.
 - j. T & S Brass and Bronze Works, Inc.
 - k. Zurn Industries, LLC; Commercial Brass and Fixtures.
 - 2. Standard: ASME A112.18.1/CSA B125.1.
 - 3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.
 - 4. Body Type: Center set on 4- inch centers.
 - 5. Body Material: General-duty, solid brass.
 - 6. Finish: Chrome plated.

7. Maximum Flow Rate: 1.5 gpm.
 8. Handle(s): Lever blade, 2 inches.
 9. Mounting Type: Deck, exposed.
 10. Spout Type: 10-inch arc tube spout with integral restriction pin.
- E. Science Sink Faucets: Accessible, manual type, single hole, wrist-blade-handle mixing valve.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Chicago Faucets; Model No. 930-VR317CP-E3-2JKCP or comparable product by one of the following:
 - a. Delta Faucet Company.
 - b. GROHE America, Inc.
 - c. Just Manufacturing.
 - d. Moen Incorporated.
 - e. Speakman Company.
 - f. T & S Brass and Bronze Works, Inc.
 - g. Zurn Plumbing Products Group.
 2. Standard: ASME A112.18.1/CSA B125.1/ADA ANSI/ICC A117.1.
 3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.
 4. Body Type: Single hole with anti-rotational body deck pin.
 5. Body Material: Commercial, solid brass.
 6. Finish: Chrome plated.
 7. Maximum Flow Rate: 2.2 gpm.
 8. Handle(s): Wrist blade, 4 inches.
 9. Mounting Type: Deck, exposed.
 10. Spout Type: 6 inch rigid gooseneck with integral vacuum breaker.
 11. Spout Outlet: Pressure compensating aerator with spout adapter design.
- F. Science Sink Faucets: Manual type, single hole, two-cross-handle mixing valve.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Chicago Faucets; Model No. 930-VRCP-E3-2JKCP or comparable product by one of the following:
 - a. Delta Faucet Company.
 - b. GROHE America, Inc.
 - c. Just Manufacturing.
 - d. Moen Incorporated.

- e. Speakman Company.
 - f. T & S Brass and Bronze Works, Inc.
 - g. Zurn Plumbing Products Group.
2. Standard: ASME A112.18.1/CSA B125.1.
 3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.
 4. Body Type: Single hole with anti-rotational body deck pin.
 5. Body Material: Commercial, solid brass.
 6. Finish: Chrome plated.
 7. Maximum Flow Rate: 2.2 gpm.
 8. Handle(s): Cross, four arm.
 9. Mounting Type: Deck, exposed.
 10. Spout Type: 6 inch rigid gooseneck with integral vacuum breaker.
 11. Spout Outlet: Pressure compensating aerator with spout adapter design.

G. Science Faucets: Serrated nozzles.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Chicago Faucets; Model No. E7JKCP or comparable product by one of the following:
 - a. Delta Faucet Company.
 - b. GROHE America, Inc.
 - c. Just Manufacturing.
 - d. Moen Incorporated.
 - e. Speakman Company.
 - f. T & S Brass and Bronze Works, Inc.
2. Chrome plated.
3. 3/8 inch - 18 NPSM male inlet.
4. 10 serrations for typical Laboratory Hoses.

H. Handwash Sink Faucet:

1. Basis-of-Design Product: Subject to compliance with requirements, Elkay Manufacturing Co; Model LK406GN05T4 or comparable product by one of the following:
 - 1) American Standard America.
 - 2) Bradley Corporation.
 - 3) Chicago Faucets.
 - 4) Delta Faucet Company.

- 5) Elkay Manufacturing Co.
- 6) GROHE America, Inc.
- 7) Just Manufacturing.
- 8) Kohler Co.
- 9) Moen Incorporated.
- 10) Speakman Company.
- 11) T & S Brass and Bronze Works, Inc.
- 12) Zurn Plumbing Products Group.

2. Standard: ASME A112.18.1/CSA B125.1.
3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.
4. Body Type: Centerset.
5. Body Material: Commercial, solid brass.
6. Finish: Chrome plated.
7. Maximum Flow Rate: 1.5 gpm.
8. Handle(s): Wrist blade, 4 inches.
9. Mounting Type: Deck, exposed.
10. Spout Type: Rigid gooseneck.
11. Spout Outlet: Aerator.

2.5 SUPPLY FITTINGS

- A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for supply-fitting materials that will be in contact with potable water.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide McGuire Manufacturing, Inc. No. LF2167-F or comparable product by one of the following:
 1. American Standard America
 2. Zurn Industries, LLC; Commercial Brass and Fixtures.
- C. Standard: ASME A112.18.1/CSA B125.1.
- D. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated brass escutcheon with set screw.
- E. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
- F. Operation: Wheel handle.

G. Risers:

1. NPS 1/2.
2. ASME A112.18.6, braided or corrugated stainless-steel flexible hose.

2.6 DRAINS

A. Drain Fitting:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Elkay Manufacturing Co No. LK35 or comparable product by one of the following:
 - a. Just Manufacturing.
 - b. Zurn Industries, LLC; Commercial Brass and Fixtures.
2. Standard: ASME A112.18.2/CSA B125.2.
3. Drain: Conical basket strainer with removable stopper and chrome plated brass NPS 1-1/2 by 4 inch tailpiece.
4. Material: Stainless steel body with polished finish.

B. Offset Drain Fitting:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Elkay Manufacturing Co No. LK35L or comparable product by one of the following:
 - a. Just Manufacturing.
 - b. Zurn Industries, LLC; Commercial Brass and Fixtures.
2. Standard: ASME A112.18.2/CSA B125.2.
3. Drain: Conical basket strainer with removable stopper and NPS 1-1/2 inch chrome plated brass 90° elbow.
4. Material: Stainless steel body with polished finish.

C. Dishwasher Tailpiece:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Dearborn Brass.
 - b. ROC Industries, Inc.
 - c. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
2. Standard: ASME A112.18.2/CSA B125.2.
3. Material: Chrome plated 17-gauge seamless brass tailpiece with 3/4 inch dishwasher connection and cast brass nuts.

D. Continuous Waste Fittings:

1. Basis-of-Design Product: Subject to compliance with requirements, provide McGuire Manufacturing, Inc. No. 111C16G17 or comparable product by one of the following:
 - a. American Standard America.
 - b. Zurn Industries, LLC; Commercial Brass and Fixtures.
2. Standard: ASME A112.18.2/CSA B125.2.
3. Material: End outlet continuous waste with satin plated cast brass tee, chrome plated 17-gauge seamless brass waste arms, brass tailpiece and cast brass nuts.
4. Size: NPS 1-1/2 by NPS 1-1/2.

2.7 TRAPS

A. Sink Traps:

1. Basis-of-Design Product: Subject to compliance with requirements, provide McGuire Manufacturing, Inc. No. 8912-F or comparable product by one of the following:
 - a. American Standard America.
 - b. Zurn Industries, LLC; Commercial Brass and Fixtures.
2. Material: Chrome-plated, two-piece, cast-brass trap and ground-joint swivel elbow, 17-gauge brass tube to wall with cleanout plug. Include chrome-plated brass escutcheon with set screw.
3. Standard: ASME A112.18.2/CSA B125.2.
4. Size: NPS 1-1/2 by 1-1/2.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before sink installation.
- B. Examine walls, floors, and counters for suitable conditions where sinks will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.
- D. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 INSTALLATION

- A. Install sinks level and plumb according to roughing-in drawings.
- B. Install supports, affixed to building substrate, for wall-hung sinks.

- C. Install water-supply piping with stop on each supply to each sink faucet. Install stops in locations that are accessible for ease of operation.
- D. Install trap and waste piping on each drain outlet of each sink to be connected to sanitary drainage system.
- E. Install accessible wall-mounted sinks at handicapped/elderly mounting height according to ICC/ANSI A117.1.
- F. Set floor-mounted sinks in leveling bed of cement grout.
- G. Install wall flanges or escutcheons at piping wall penetrations and casework penetrations. Comply with escutcheon requirements specified in Section 22 05 18 "Escutcheons for Plumbing Piping."
- H. Seal joints between sinks and counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants" and sink manufacturer's recommendations.
- I. Install protective shielding pipe covers on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 22 07 19 "Plumbing Piping Insulation."

3.3 CONNECTIONS

- A. Connect sinks with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

3.4 FIELD QUALITY CONTROL

- A. Comply with "Field Quality Control" article in Part 3 of Section 22 05 00 "Common Work Results for Plumbing" for lead testing requirements prior to commencing any work.
- B. Inspecting Agency: Engage a qualified laboratory to perform lead testing on all potable water faucets installed under this contract and used or potentially used for drinking or cooking purposes according to NYS Law 10 CRR-NY 67-4.1. Submit test results to the Owner and the Architect.
- C. Replace any faucet that exceeds the lead action level (5 micrograms per liter) and coordinate with the Owner for retesting until satisfactory results are obtained.

3.5 ADJUSTING

- A. Operate and adjust sinks and controls. Replace damaged and malfunctioning sinks, fittings, and controls.
- B. Adjust water pressure at faucets to produce proper flow.

3.6 CLEANING AND PROTECTION

- A. After completing installation of sinks, inspect and repair damaged finishes.
- B. Clean sinks, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed sinks and fittings.
- D. Do not allow use of sinks for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 42 16.16

SECTION 22 45 00 - EMERGENCY PLUMBING FIXTURES**PART 1 - GENERAL****1.1 SUMMARY**

- A. Section Includes:
 - 1. Combination units.
 - 2. Water-tempering equipment.

1.2 DEFINITIONS

- A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.
- B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.
- C. Tepid: Between 60 and 100 deg F.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories.
 - 1. Accessible, plumbed emergency shower with eyewash combination units.
 - 2. Hot-and cold-water, water-tempering equipment – EM TMV-1.
 - 3. Hot-and cold-water, water-tempering equipment – EM TMV-2.
- B. Shop Drawings:
 - 1. Plans, elevations, sections, and attachment details.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For emergency plumbing fixtures.
- B. Field quality-control reports.

PART 2 - PRODUCTS**2.1 PERFORMANCE REQUIREMENTS**

- A. Comply with ANSI/ISEA Z358.1 for emergency plumbing fixtures including third-party certification of fixtures.
- B. Comply with ASSE 1071 for temperature-actuated mixing valves for plumbed emergency fixtures.
- C. Comply with ASME A112.18.1/CSA B125.1 for water-supply fittings.

- D. Comply with ASME A112.18.2/CSA B125.2 for plumbing waste fittings.
- E. Comply with NSF 61 and NSF 372 for fixture materials that will be in contact with potable water.
- F. Comply with requirements in ICC A117.1 for plumbing fixtures for people with disabilities.

2.2 COMBINATION UNITS

A. Accessible, Plumbed Emergency Shower with Eyewash Combination Units:

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide Bradley Corporation; No. S19314 or comparable product by one of the following:
 - a. Acorn Safety; a division of Acorn Engineering Company.
 - b. Encon Safety Products.
 - c. Guardian Equipment Co.
 - d. Haws Corporation.
 - e. Speakman Company.
 - f. WaterSaver Faucet Co.
- 2. Piping:
 - a. Material: Galvanized steel with factory applied safety yellow coating.
 - b. Unit Supply: NPS 1-1/4 minimum.
 - c. Unit Drain: Outlet at back or side near bottom.
- 3. Shower:
 - a. Capacity: Not less than 20 gpm for at least 15 minutes.
 - b. Supply Piping: NPS 1-1/4 with flow regulator and stay-open control valve.
 - c. Control-Valve Actuator: Pull rod.
 - d. Shower Head: 8-inch-minimum diameter, chrome-plated brass or stainless steel.
 - e. Mounting: Pedestal.
- 4. Eyewash Unit:
 - a. Capacity: Not less than 0.4 gpm for at least 15 minutes.
 - b. Supply Piping: NPS 1/2 with flow regulator and stay-open control valve.
 - c. Control-Valve Actuator: Paddle.
 - d. Spray-Head Assembly: Two receptor-mounted spray heads.
 - e. Receptor: Chrome-plated brass or stainless-steel bowl.
 - f. Mounting: Attached shower pedestal.

2.3 WATER-TEMPERING EQUIPMENT

A. Eyewash Hot- and Cold-Water, Water-Tempering Equipment - EM TMV-1:

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide Bradley Corporation; Navigator No. S19-2000 (EFX8) or comparable product by one of the following:
 - a. Armstrong International, Inc.

- b. Haws Corporation.
 - c. Lawler Manufacturing Co., Inc.
 - d. Speakman Company.
 - 2. Description: Factory-fabricated equipment with thermostatic mixing valve.
 - a. Thermostatic Mixing Valve: Designed to provide 85 deg F tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 3 deg F throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, metal piping, and corrosion-resistant enclosure.
 - 3. Pressure Rating: 125 psig.
 - 4. Type: Recessed-mounted cabinet-type, compact body design, thermostatically controlled, emergency fixture thermostatic mixing valve.
 - 5. Material: Bronze body with corrosion-resistant interior components.
 - 6. Connections: Threaded inlets and outlet.
 - 7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
 - 8. Valve Finish: Rough bronze.
 - 9. Piping Finish: Copper.
 - 10. Cabinet: Factory fabricated, stainless steel, for recessed mounting and with hinged, stainless-steel door.
- B. Shower Hot- and Cold-Water, Water-Tempering Equipment – EM TMV-2:
- 1. Basis-of-Design Product: Subject to compliance with requirements, provide Bradley Corporation; Navigator No. S19-2250 (EFX50) or comparable product by one of the following:
 - a. Armstrong International, Inc.
 - b. Haws Corporation.
 - c. Lawler Manufacturing Co., Inc.
 - d. Speakman Company.
 - 2. Description: Factory-fabricated equipment with thermostatic mixing valve.
 - a. Thermostatic Mixing Valve: Designed to provide 85 deg F tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 3 deg F throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, metal piping, and corrosion-resistant enclosure.
 - 3. Pressure Rating: 125 psig.

4. Type: Recessed-mounted cabinet-type, compact body design, thermostatically controlled, emergency fixture thermostatic mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded inlets and outlet.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Valve Finish: Rough bronze.
9. Piping Finish: Copper.
10. Cabinet: Factory fabricated, stainless steel, for recessed mounting and with hinged, stainless-steel door.

2.4 TESTING EQUIPMENT

A. Eyewash Test Gauge:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Bradley Corporation; No. 269-1444 or comparable product by one of the following:
 - a. Acorn Safety; a division of Acorn Engineering Company.
 - b. Encon Safety Products.
 - c. Guardian Equipment Co.
 - d. Haws Corporation.
 - e. Speakman Company.
 - f. WaterSaver Faucet Co.
2. Transparent compliance gauge with testing instructions printed on the test gauge and integral 8-inch scale to assist in evaluation of spray pattern height.
3. Illustrations compliant with American National Standard Z358.1-2009.

B. Drench Shower Tester:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Bradley Corporation; No. S19-330ST or comparable product by one of the following:
 - a. Acorn Safety; a division of Acorn Engineering Company.
 - b. Encon Safety Products.
 - c. Guardian Equipment Co.
 - d. Haws Corporation.
 - e. Speakman Company.
 - f. WaterSaver Faucet Co.
2. Heavy-duty, watertight and chemical-resistant nylon funnel with weighted bottom and telescoping aluminum handle.

3. Funnel characteristics:
 - a. Overall length: 84 inches.
 - b. Funnel diameter at the top: 15 inches.
 - c. Funnel diameter at the bottom: 5 inches.
4. 5-gallon plastic bucket not included.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 INSTALLATION OF EMERGENCY PLUMBING FIXTURE

- A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.
- B. Install fixtures level and plumb.
- C. Fasten fixtures to substrate.
- D. Install shutoff valves in water-supply piping to fixtures. Use ball valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation. Comply with requirements for valves specified in Section 22 05 23 "General-Duty Valves for Plumbing Piping."
- E. Install dielectric fitting in supply piping to emergency equipment if piping and equipment connections are made of different metals. Comply with requirements for dielectric fittings specified in Section 22 11 16 "Domestic Water Piping."
- F. Install trap and waste piping on drain outlet of emergency equipment receptors that are indicated to be directly connected to drainage system. Comply with requirements for waste piping specified in Section 22 13 16 "Sanitary Waste and Vent Piping."
- G. Install indirect waste piping on drain outlet of emergency equipment receptors that are indicated to be indirectly connected to drainage system. Comply with requirements for waste piping specified in Section 22 13 16 "Sanitary Waste and Vent Piping."
- H. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Comply with requirements for escutcheons specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

3.3 PIPING CONNECTIONS

- A. Connect hot- and cold-water-supply piping to hot- and cold-water, water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures. Comply with requirements for hot- and cold-water piping specified in Section 22 11 16 "Domestic Water Piping."
- B. Directly connect emergency plumbing fixture receptors with trapped drain outlet to sanitary waste and vent piping. Comply with requirements for waste piping specified in Section 22 13 16 "Sanitary Waste and Vent Piping."
- C. Indirectly connect emergency plumbing fixture receptors without trapped drain outlet to sanitary waste or storm drainage piping.
- D. Where installing piping adjacent to emergency plumbing fixtures, allow space for service and maintenance of fixtures.

3.4 IDENTIFICATION

- A. Install equipment nameplates or equipment markers on emergency plumbing fixtures and equipment and equipment signs on water-tempering equipment. Comply with requirements for identification materials specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."
- B. Install valve function signage on isolation valves serving emergency fixtures. Comply with requirements for identification materials specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.5 FIELD QUALITY CONTROL

- A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities.
- B. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection.
 - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: Start units to confirm proper unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 5. Emergency plumbing fixtures and water-tempering equipment will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Operate and adjust emergency plumbing fixtures and controls. Replace damaged and malfunctioning fixtures and controls.
- B. Adjust or replace fixture flow regulators for proper flow.
- C. Adjust equipment temperature settings.

3.7 CLEANING AND PROTECTION

- A. Clean emergency plumbing fixtures with manufacturers' recommended cleaning methods and materials.
- B. Install protective covering for installed emergency plumbing fixtures and fittings.
- C. Do not allow use of emergency plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 45 00

SECTION 22 47 16 - PRESSURE WATER COOLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Pressure water coolers.
 - 2. Supports.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of pressure water cooler and bottle filling station include construction details, material descriptions, dimensions of individual components and profiles, finishes, rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 1. Surface Wall-Mounted, Bi-level Stainless Steel.
 - 2. Supply fittings.
 - 3. Traps.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For pressure water coolers and bottle filling stations to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Water Conservation:
 - 1. Provide plumbing fixtures complying with applicable provisions of Section 604.4 of the Plumbing Code of New York State.

1.6 FIELD CONDITIONS

- A. Refer to the "Project/Site Conditions" article in Section 22 05 00 "Common Work Results for Plumbing" for lead testing requirements prior to commencing any work.
- B. Coordinate potable water lead testing with Owner prior to starting any construction.

1.7 MAINTENANCE MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filter Cartridges: Equal to 10 percent of quantity installed for each type and size indicated, but no fewer than 5 of each.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Standards:
 - 1. Pressure water coolers and bottle filling stations intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61 or NSF 372, or be certified in compliance with NSF 61 or NSF 372 by an ANSI-accredited third-party certification body, that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.
 - 2. Comply with ASHRAE 34 for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant unless otherwise indicated.
 - 3. Comply with UL 399.
 - 4. Comply with ASME A112.19.3/CSA B45.4.
 - 5. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 6. Comply with NSF 42 and NSF 53 for water filters for water coolers and bottle filling stations.
 - 7. Comply with ICC A117.1 for accessible water coolers and bottle filling stations.

2.2 PRESSURE WATER COOLERS

- A. Pressure Water Coolers - Surface Wall-Mounted, Bi-level Stainless Steel: (EWC "A").
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Elkay; Model No. LZSTL8WSSK with Model 51299C Lead + Microplastics Filter or a comparable product by one of the following:
 - a. Halsey Taylor.
 - b. Murdock Manufacturing; A Division of Morris Group International.
 - c. Oasis International.

2. Source Limitations: Obtain surface wall-mounted, stainless steel, pressure water coolers from single source from single manufacturer.
3. Cabinet: Bi-level with two attached cabinets and one bottle filling station, all stainless steel.
4. Bubbler: Abrasion-resistant, anti-sweat, pliable polyester elastomer with infused anti-microbial, keyed in location to prevent rotation, with adjustable stream regulator, located on cabinet deck.
5. Control: Push bar on front and sides of each cabinet.
6. Bottle Filling Station: Stainless steel construction with ABS plastic alcove and the following features:
 - a. Electronic sensor for touchless activation with auto 20-second shut off.
 - b. Filling Rate: 1.1 gpm.
 - c. Laminar flow to minimize splashing.
 - d. Integral drain to eliminate standing water.
 - e. LED visual filter monitor to indicate when filter requires replacement.
7. Drain: Grid with NPS 1-1/4 tailpiece.
8. Supplies: Comply with requirements in "Supply Fittings" Article.
9. Trap: Comply with requirements in "Trap" Article.
10. Filter: NSF/ANSI Certified filter designed to reduce lead, particles and chlorine.
 - a. Tested and certified to NSF 42 and 53 for lead, Class 1 particulate, chlorine taste and odor reduction.
 - b. Tested and certified to NSF/ANSI 401 for the reduction of microplastics.
11. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
 1. Support: Water-cooler carrier.
 2. Capacities and Characteristics:
 - a. Cooled Water: 8 gph.
 - b. Ambient-Air Temperature: 90 deg F.
 - c. Inlet-Water Temperature: 80 deg F.
 - d. Cooled-Water Temperature: 50 deg F.
 - e. Electrical Characteristics:
 - 1) Motor Horsepower: 1/5.
 - 2) Volts: 120 V ac.

- 3) Phase: Single.
- 4) Hertz: 60 Hz.
- 5) Full-Load Amperes: 6 A.

2.3 SUPPLY FITTINGS

- A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for supply-fitting materials that will be in contact with potable water.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide McGuire Manufacturing, Inc. No. LFBV07-F or comparable product by one of the following:
 1. American Standard America
 2. Zurn Industries, LLC; Commercial Brass and Fixtures.
- C. Standard: ASME A112.18.1/CSA B125.1.
- D. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated brass escutcheon with set screw.
- E. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
- F. Operation: Wheel handle.
- G. Risers:
 1. NPS 3/8.
 2. ASME A112.18.6, braided or corrugated stainless-steel flexible hose.

2.4 TRAPS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide McGuire Manufacturing, Inc. No. 8872C-F or comparable product by one of the following:
 1. American Standard America.
 2. Zurn Industries, LLC; Commercial Brass and Fixtures.
- B. Material: Chrome-plated, two-piece, cast-brass trap and ground-joint swivel elbow, 17- gauge brass tube to wall with cleanout plug. Include chrome-plated brass escutcheon with set screw.
- C. Standard: ASME A112.18.2/CSA B125.2.
- D. Size: NPS 1-1/4 by 1-1/4.

2.5 SUPPORTS

A. Water-Cooler Carrier:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith Mfg Co; a division of Morris Group International; 0834 Series or a comparable product by one of the following:
 - a. Josam Company.
 - b. MIFAB, Inc.
 - c. Wade Drains.
 - d. Zurn Industries, LLC.
2. Standard: ASME A112.6.1M.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.
- B. Examine walls and floors for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install fixtures level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.
- B. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.
- C. Install mounting frames, affixed to building construction, and attach recessed, pressure water coolers, and bottle filling stations to mounting frames.
- D. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping.
- E. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
- F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 22 05 18 "Escutcheons for Plumbing Piping."
- G. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."

3.3 PIPING CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."
- C. Install ball shutoff valve on water supply to each fixture. Install valve upstream from filter for water cooler. Comply with valve requirements specified in Section 22 05 23 "General Duty Valves for Plumbing Piping"
- D. Comply with soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

3.4 ELECTRICAL CONNECTIONS

- A. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- B. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

3.5 FIELD QUALITY CONTROL

- A. Inspecting Agency: Engage a qualified laboratory to perform lead testing on all potable water fixtures installed under this contract and used or potentially used for drinking or cooking purposes according to NYS Law 10 CRR-NY 67-4.1.
- B. Replace any drinking fountain that exceeds the lead action level (5 micrograms per liter) and coordinate with the Owner for retesting until satisfactory results are obtained.

3.6 ADJUSTING

- A. Adjust fixture flow regulators for proper flow and stream height.
- B. Adjust pressure water-cooler temperature settings.

3.7 CLEANING

- A. After installing fixture, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.
- C. Provide protective covering for installed fixtures.
- D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 47 16

SECTION 22 66 00 - CHEMICAL-WASTE SYSTEMS FOR LABORATORY FACILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Single-wall piping.
 - 2. Piping specialties.
 - 3. Neutralization tanks.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. PP drainage pipe and fittings
 - 2. Adapters and transition fittings
 - 3. Corrosion-resistant traps
 - 4. PP sink outlets
 - 5. Plastic neutralization tanks

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For chemical-waste specialties and neutralization tanks to include in emergency, operation, and maintenance manuals.
- B. Field quality-control reports.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Neutralization-Tank Limestone: Equal to 200 percent of amount required for each tank sump initial charge. Furnish limestone in 50-lb bags.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store piping and specialties with sealing plugs in ends or with end protection.
- B. Do not store plastic pipe or fittings in direct sunlight.
- C. Protect pipe, fittings, and seals from dirt and damage.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Single-Wall Piping Pressure Rating: 10 feet head of water for 30 minutes.

2.2 SINGLE-WALL PIPE AND FITTINGS

- A. PP Drainage Pipe and Fittings: ASTM F1412, extruded pipe and drainage-pattern fittings molded, with Schedule 40 dimensions and with fire-retardant additive complying with ASTM D 4101; with fusion- and mechanical-joint ends.
 - 1. Exception: Pipe and fittings made from PP resin without fire-retardant additive may be used for underground installation.
 - 2. Basis-of-Design Product: Subject to compliance with requirements, provide IPEX USA LLC ; Enfield / Labline. or a comparable product by one of the following:
 - a. GF Piping Systems: Georg Fischer LLC.
 - b. Orion Fittings; A WATTS Brand.
 - 3. Source Limitations: Obtain pipe and fittings from single source from single manufacturer.
 - 4. Electrofusion Fittings: Schedule 40 molded fittings with an integral nickel/chrome electrical resistance wire molded with the fitting body.
 - a. Dissimilar Pipe Joins: Provide coordinating adapters per manufacturer's recommendations.
 - 5. Mechanical Fittings: Integrally molded union designed to lock into a groove machined into mating pipe.
- B. Adapters and Transition Fittings: Assemblies with combinations of clamps, couplings, adapters, and gaskets; compatible with piping and system liquid; made for joining different piping materials.

2.3 JOINING MATERIALS

- A. Couplings: Assemblies with combinations of clamps, gaskets, sleeves, and threaded or flanged parts; compatible with piping and system liquid; and made by piping manufacturer for joining system piping.

- B. Adapters and Transition Fittings: Assemblies with combinations of clamps, couplings, adapters, gaskets, and threaded or flanged parts; compatible with piping and system liquid; and made for joining different piping materials.
- C. Flanges: Assemblies of companion flanges and gaskets complying with ASME B16.21 and compatible with system liquid, and bolts and nuts.

2.4 PIPING SPECIALTIES

- A. Corrosion-Resistant Traps:
 - 1. Type: P-trap.
 - 2. Size: NPS 1-1/2 or NPS 2, as required to match connected piping.
 - 3. PP: ASTM D4101, with mechanical-joint pipe connections.
- B. PP Sink Outlets:
 - 1. Description: NPS 1-1/2, with clamping device, stopper, and 7-inch-high overflow fitting.

2.5 NEUTRALIZATION TANKS

- A. Plastic Neutralization Tanks
 - 1. Description: Cylindrical, Corrosion-resistant plastic materials; with removable, gastight cover; interior, sidewall, dip-tube inlet; outlet; vent; and threaded or flanged, sidewall pipe connections.
 - 2. Basis-of-Design Product: Subject to compliance with requirements, provide IPEX USA LLC ; Neutratank. or a comparable product by one of the following:
 - a. Chem-Tainer Industries.
 - b. GF Piping Systems: Georg Fischer LLC.
 - c. Orion Fittings; A WATTS Brand.
 - d. Schier Products Company.
 - e. Town & Country Plastics, Inc.
 - f. WATTS.
 - g. Zurn Industries, LLC.
 - 3. Source Limitations: Obtain tanks from single source from single manufacturer.
 - 4. Material: HDPE or ASTM D4101 PP. Mechanical joint pipe connections.
 - 5. Tank Capacity: 55 gallon.
 - 6. Limestone: Chips or lumps, with more than 90 percent calcium carbonate content and 1-to 3-inch diameter.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Chemical-Waste Piping Inside the Building:

1. Install piping adjacent to equipment, accessories, and specialties, to allow space for service and maintenance.
2. Transition and special fittings with pressure ratings at least equal to piping pressure rating may be used unless otherwise indicated.
3. Flanges may be used on aboveground piping unless otherwise indicated.
4. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
5. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
6. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
7. Install piping at indicated slopes.
8. Install piping free of sags and bends.
9. Install fittings for changes in direction and branch connections.
10. Verify final equipment locations for roughing-in.
11. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."
12. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

3.2 JOINT CONSTRUCTION

A. Chemical-Waste Piping Inside the Building (except exposed piping in casework):

1. Plastic-Piping Fusion Joints: Make PP drainage-piping joints in accordance with ASTM F1290.
2. Dissimilar-Material Piping Joints: Make joints using adapters compatible with both system materials.

3.3 HANGER AND SUPPORT INSTALLATION

- A. Pipe sizes in this article refer to aboveground single-wall piping.
- B. Comply with requirements in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices. Install the following:
 - 1. Vertical Piping: MSS Type 8 or MSS Type 42 riser clamps.
 - 2. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52 spring hangers.
- C. Comply with requirements in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment" for installation of supports.
- D. Support horizontal piping and tubing within 12 inches of each fitting and coupling.
- E. Support vertical piping and tubing at base and at each floor.
- F. Rod diameter may be reduced one size for double-rod hangers, to minimum of 3/8 inch.
- G. Install vinyl-coated hangers for PP piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 2: 33 inches with 3/8-inch rod.
 - 2. NPS 2-1/2 and NPS 3: 42 inches with 1/2-inch rod.
- H. Install supports for vertical PP piping every 72 inches.
- I. Support piping and tubing not listed above in accordance with MSS SP-58.

3.4 NEUTRALIZATION TANK INSTALLATION

- A. Install interior neutralization tanks on smooth and level floor surface. Include full initial charge of limestone.

3.5 PIPING CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to equipment, allow space for service and maintenance.

3.6 LABELING AND IDENTIFICATION

- A. Comply with requirements in Section 22 05 53 "Identification for Plumbing Piping and Equipment" for labeling of equipment and piping.

3.7 CLEANING

- A. Use procedures prescribed by authorities having jurisdiction or, if not prescribed, use procedures described below:
 - 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 - 2. Clean piping by flushing with potable water.

3.8 FIELD QUALITY CONTROL

- A. Inspect interior of sewerage piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place and again at completion of Project.
 - 1. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between inspection points.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - c. Crushed, broken, cracked, or otherwise damaged piping.
 - d. Hydrostatic Tests for Drainage Piping:
 - 1) Close openings in system and fill with water.
 - 2) Purge air and refill with water.
 - 3) Disconnect water supply.
 - 4) Test and inspect joints for leaks.
 - e. Air Tests for Drainage Piping: Comply with UNI-B-6.
 - 2. Leaks and loss in test pressure constitute defects that must be repaired.
 - 3. Submit separate reports for each test.
- B. Replace leaking sewerage piping using new materials and repeat testing until no leaks exist.
- C. Perform tests and inspections with the assistance of a factory-authorized service representative.

D. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Chemical-waste piping will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.9 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping pressure rating may be used in applications below unless otherwise indicated.

B. Exposed Chemical-Waste Piping in Casework and at connection to neutralization basin: Use the following piping materials for each size range:

1. NPS 1-1/2 to NPS 3: PP drainage piping and mechanical joints.

C. Aboveground Chemical-Waste Piping: Use the following piping materials for each size range:

1. NPS 1-1/2 to NPS 6: PP drainage piping and fusion joints.

END OF SECTION 22 66 00

SECTION 23 01 20 – HYDRONIC SYSTEMS CLEANING AND WATER TREATMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Hydronic systems cleaning and water treatment specialty components and chemicals.
 - 2. Heat transfer fluids and system filling components.
 - 3. Flushing, cleaning, filling, venting and treatment of hydronic piping distribution systems (heating and /or cooling systems with and without glycol).
- B. Flushing, cleaning, venting, and filling of hydronic systems includes but is not limited to flushing and cleaning of all new piping distribution systems and all existing piping distribution systems that are extended or connected to as part of this project, unless noted otherwise on drawings. Perform all work under the direction of a qualified Water Treatment Services Company (WTSC).
- C. Initial water analysis and chemical treatment of hydronic systems as described below, provided complete by an approved WTSC.
- D. After systems have been proven clean, final filled, initial chemical treatment of system has been performed, and system is turned over in proper condition and accepted as such by Owner, then, subsequent chemical treatment of hydronic systems will be provided by Owner.

1.3 SUBMITTALS

- A. Qualification Data: Submit name, qualifications, and references of WTSC.
- B. Product Data: Submit data on proposed specialty equipment and glycol mixture demonstrating conformance with specified product characteristics.
- C. Closeout Submittals for inclusion in Operations and Maintenance Manual:
 - 1. System Cleaning Report: Provide report on initial system cleaning and treatment including copies of strainer cleaning log books, system fill volume, makeup water and system water test results, chemicals used (type and volume/mass), recommended and final chemical concentrations, and other pertinent water quality data as required to maintain system in optimum condition.

2. Operation and Maintenance Data: Include all instructions for maintenance, cleaning, and ongoing chemical treatment of hydronic systems in project maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Water Treatment Services Company (WTSC) Qualifications: A company with minimum 5 years documented successful experience specializing in cleaning and chemical treatment of HVAC piping systems of comparable or greater size and complexity as required on this project, that is capable of analyzing water qualities, installing water-treatment equipment, and applying chemicals and other water treatment as specified in this Section.

PART 2 - PRODUCTS

2.1 CHEMICAL TREATMENT AND FILTRATION HYDRONIC SPECIALTIES

- A. Combination Chemical Shot Feeder / Bag Filter: Bypass type chemical feeder with integral bag filter of 5-gallon capacity, ASME Rated, welded steel construction with 125 PSIG working pressure, complete with 1-inch inlet and outlet valved connections, 3-inch course thread hand-tighten high pressure top fill connection, dished-out full bottom drain with valve, and support legs. Include filter bag kit with filter bags sufficient to clean system plus (10) spare 50 micron bag filters.

1. Manufacturers: Griswold Water Systems, J.L.Wingert Co.

2.2 TREATMENT CHEMICALS

- A. Provide approved system treatment chemicals as directed by water treatment services company.

2.3 HEAT TRANSFER FLUIDS

- A. Water: Provide de-oxygenated and corrosion inhibited water as required to maintain warranties of all existing equipment and equipment provided as a part of this project, and as additionally required by these specifications. Remove dissolved and suspended impurities and contaminants and add proper chemical treatment as required.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine piping distribution systems, both new piping installed in this project and existing piping on the affected systems.
 1. Look for automatic and manual vents at end of all horizontal piping runs before elevation drop. Provide additional vents as required for proper air elimination.

2. Look for system connection ports to provide for filling, draining, and circulation of piping. Provide additional valves and connections as required, or drain, fill, clean, and treat entire system.
 3. Look for isolation valves as required to isolate those portions of the system not needing cleaning and treatment. Provide additional valves as required and isolate those portions of the system not being cleaned.
- B. Proceed with cleaning only after unsatisfactory conditions have been corrected.
- C. Beginning cleaning constitutes Contractor's acceptance of systems and conditions.

3.2 HYDRONIC SPECIALTIES INSTALLATION

- A. Combination Chemical Shot Feeder / Bag Filter: Install in each hydronic system where indicated, on concrete housekeeping pad, in upright position with top of fill cap not more than 48 inches above the floor. Provide minimum NPS 1 inch piping across system pumps with pump discharge piped to filter feeder inlet and filter feeder outlet piped to pump suction. Provide line size full-port ball valves in the bypass connections in easily accessible locations, sight flow indicator, and unions. Provide with pressure gauge in accordance with section 23 05 19 – Meters and Gauges for HVAC. Install NPS 3/4 pipe from chemical feeder drain, to nearest equipment drain and include a full-size, full-port, ball valve. Install piping and valves to eliminate introduction of air into system from filter feeder operation, including valves at connection level where possible or with manual vent at isolation valves in riser.

3.3 PREPARATION AND PROTECTION OF SYSTEMS

- A. At all times from beginning of cleaning of water systems until final acceptance by Owner, provide free oxygen removal and chemical treatment of hydronic systems to protect system components against internal corrosion (or additional corrosion in the case of existing piping and boilers).
1. Do not fill hydronic-heating systems until firing equipment is operable and all aspects of installation are prepared for startup. Do not subject any system to water that has not been de-oxygenated for periods longer than 4 hours. Provide approved de-oxygenation strategy as required to remove free oxygen and prevent corrosion of boilers, pumps, other system components, and piping.
 - a. Heating water to provide de-oxygenation of heating systems will be an acceptable procedure. Provide heated water to remove free oxygen and prevent corrosion and premature failure of boilers and piping. Start boilers as specified in Project Manual and in accordance with ASME Boiler and Pressure Vessel Code immediately upon filling and proceed to heat system water to at least 190 deg. F while circulating entire system at temperature for at least two hours and actively venting air.

2. Provide services of approved WTSC to perform the following:
- a. Obtain and coordinate with hydronic equipment manufacturers' published water quality guidelines as required to maintain equipment warranties. Include copy of this data in report.
 - b. Test existing system water and make-up water prior to and during system flushing, cleaning, and venting and prescribe proper water treatment to clean system and maintain boiler, piping, controls, and all other hydronic specialties' warranties and prevent corrosion or deterioration (further corrosion or deterioration in the case of existing systems) of each entire hydronic system due to oxygen, acid, scaling, or other water or glycol solution related problems. Consider and report on the following characteristics at a minimum, and recommend acceptable range of values for this project's systems individually, using specified values as a starting point only:
 - 1) pH: 9.0 to 10.5.
 - 2) "P" Alkalinity: 100 to 500 ppm.
 - 3) Boron: 100 to 200 ppm.
 - 4) Chemical Oxygen Demand: Maximum 100 ppm.
 - 5) Soluble Copper: Maximum 0.20 ppm.
 - 6) Tolyiriazole Copper, Yellow Metal Corrosion Inhibitor: Minimum 10 ppm.
 - 7) Total Suspended Solids: Maximum 10 ppm.
 - 8) Ammonia: Maximum 20 ppm.
 - 9) Free Caustic Alkalinity: Maximum 20 ppm.
 - 10) Reserve Alkalinity:
 - 11) Corrosion Inhibitor, any of the below or as recommended by WTSC:
 - a) Sodium Nitrate: 1000 to 1500 ppm.
 - b) Molybdate: 200 to 300 ppm.
 - c) Chromate: 200 to 300 ppm.
 - d) Sodium Nitrate Plus Molybdate: 100 to 200 ppm each.
 - e) Chromate Plus Molybdate: 50 to 100 ppm each.
 - 12) Microbiological Limits:
 - a) Total Aerobic Plate Count: Maximum 1000 organisms/ml.
 - b) Total Anaerobic Plate Count: Maximum 100 organisms/ml.
 - c) Nitrate Reducers: 100 organisms/ml.
 - d) Sulfate Reducers: Maximum 0 organisms/ml.
 - e) Iron Bacteria: Maximum 0 organisms/ml.

- c. Provide prescribed ingredients and maintain proper water conditions until acceptance of system. Turn over in Manufacturers' approved condition.
- d. Provide certified portion of system cleaning and treatment report including manufacturer's requirements, water quality test data and recommendations, prescription chemical recommendations and data sheets, treatment schedule, and proposal for continued treatment contract for first year following system acceptance.

3.4 DRAINING, FILLING, FLUSHING, VENTING, AND CLEANING

A. Draining:

- 1. Drain systems completely as required for the contract Work so as to avoid cross contamination of system's heat transfer fluids.
- 2. Protect Owner's belongings from damage during draining and removals.
- 3. Install additional drains if necessary to completely drain system. Note that drain valves are required on all new piping low points. As part of base bid pricing, provide for four additional drains in existing piping not shown on drawings, in locations coordinated with Engineer and Owner.

B. Legally dispose of all drainage unless specifically shown on the drawings to be re-used. Filling and Venting:

- 1. Fill and vent each entire system, including portions of existing systems connected to but not modified by this Project, as required leaving entire system in a properly filled, chemically treated, air-free condition.
- 2. Fill slowly with appropriate fluid for process planned (clean water for initial flushing, system cleaning solution for system cleaning, chemically treated water or glycol solution for final fill, etc.) while operating manual and automatic vents to purge air from system.
- 3. Vent all air from hydronic systems. Open all manual vents repeatedly to relieve air and test operation of all main and branch automatic air eliminators and vents. Repair and/or replace all malfunctioning vents.
- 4. Purge systems section by section to remove residual air. Isolate piping sections and purge fluid through each section slowly in direction of normal flow to force air to vent connections without forcing air down risers.
- 5. Install additional air vents as required to fully vent system. Note that air vents are required at all new piping high points and before drops. Note locations where residual air pockets tend to remain in pre-project existing piping and install additional air vents as necessary to remove remaining air. As part of base bid pricing, provide for adding four additional automatic air vent assemblies in existing piping not shown on drawings, in locations coordinated with Engineer and Owner.
- 6. Repeat purging and venting as necessary to remove all air from each system.

7. When final venting is complete, close manual valves serving automatic air vents to prolong automatic vent service life.

C. Flushing:

1. Flush each entire system, including portions of existing systems connected to, but not modified by, this Project.
2. Flush all piping with clean water at flow rate required to produce local pipe velocity of not less than 10 feet per second. Section by section flushing as required to achieve this velocity is required.
3. Note strainers will likely become clogged repeatedly during this phase of system operation. Repeatedly clean strainers as described below as required to maintain unobstructed flow. Strainer Cleaning:
 - a. Remove, clean, and reinstall all strainer screens during and after flushing and venting (including screens of existing system strainers). Record strainer screen contents in log book. Repeat after a 2-week operating period connected to main system pumps.
 - b. Insure all pump suction diffusers have fine mesh start-up screens prior to filling system. Remove and clean all pump suction diffuser screens whenever the pressure drop across screen is double the pressure drop of a clean screen and after 2-week operating period. Record strainer screen contents in log book.
 - c. Reinstall strainer screens after cleaning. Reinstall fine mesh suction diffuser start-up screens each time they contain significant debris upon removal.
 - d. Purge and vent all air from the systems introduced as a result of strainer cleaning.
 - e. Submit strainer-cleaning report as detailed for cleaning report submittal.
4. Provide approved de-oxygenation strategy.
5. Test for and repair all leaks.
6. After each system has operated at full temperature for 2-week period and all leaks have been repaired, vent each system as specified above. Purge each system as specified above if necessary.

D. Cleaning: After each hydronic system has been leak-tested, flushed, and vented, clean system as specified below. Do not use system for temporary heat or submit for acceptance and use by Owner prior to cleaning. Do not operate pumps continuously or unattended until system is flushed and strainers cleaned. Notify Owner's Project Representative before starting cleaning.

1. Cleaning Procedures:

- a. Clean all air vents, gauge glasses, control valves, etc. and ensure free operation.

- b. Provide side stream filter across system pumps where indicated on Drawings and use to filter fine particulate from hydronic system during cleaning. Provide filter bags as required to remove all solids from system down to 5-micron size. Deliver 10 spare 5-micron filter bags to Owner.
 - c. Provide cleaning compound of sodium carbonate and trisodium phosphate, in proportions of 1lb of chemical per 50 gallons of water or as recommended specifically by WTSC and system equipment manufacturers. Mix chemicals with water and introduce into the system per equipment manufacturer's and water treatment service companies instructions, filling entire system with cleaning solution. Provide temporary meter or other means (calculated volume acceptable) of determining amount of water in system. Provide all necessary valves, fill pipe, and similar components.
 - d. Operate pumps and control system with control valves open. Circulate solution for heating system at 180 Deg. F. for at least 24 hours. Flush and vent system as required during cleaning. Remove and clean air vents, strainers, filters, and check valves, and replace improperly functioning components. Blow down solids separators, sumps, and all system low points where sediment might accumulate.
 - e. After cleaning and blow down, circulate for additional 8 hours, then clean strainers, filters, and low point blow down locations again; repeat until strainers and filters are found clean, and initial solution taken from any blow down location is clean.
 - f. Drain, flush cleaning solution with clean water, and legally dispose of drainage.
 - g. Refill with clean deoxygenated water.
2. Test for Cleanliness:
- a. Circulate for additional 24 hours and take water sample to test for cleanliness from any system low point drain or blow down valve selected by Architect or Owner by filling quart sample bottle with initial drainage included and allowing sample to settle for 12 hours. Check for floating and settled impurities. Water is considered clean if no impurities can be observed in drawn samples, and 5-micron side stream filter bag remains nominally clean after 24 hours full flow circulation. Draw samples in presence of Architect and turn over to Owner to confirm cleanliness.
 - b. Drain and repeat the starting up procedure and cleanliness test as often as required to pass "Test for Cleanliness".

3.5 FINAL FILLING OF WATER PIPING SYSTEMS

- A. Water Hydronic Systems: Thoroughly purge and vent approved cleaned system. Provide prescribed chemical treatment and turn over in manufacturers' approved condition.

END OF SECTION 23 01 20

SECTION 23 05 00 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and all Division 01 Sections, apply to this Section and to all of Division 23.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Definitions, references, and abbreviations.
 - 2. General regulatory requirements.
 - 3. General requirements regarding site/field conditions including existing conditions and field measurements.
 - 4. Sequencing and scheduling including coordination.
 - 5. Definition of design equipment and procedures for consideration of specified equivalents, proposed equivalents, or substitutions.
 - 6. HVAC demolition.
 - 7. Equipment installation requirements common to equipment sections.
 - 8. Minimum material requirements and equipment verification.
 - 9. Electrical components for HVAC Work
 - 10. Concrete bases and grout.
 - 11. Mechanical penetrations, waterproofing, and sealants.
 - 12. Fire-stopping
 - 13. Access doors
 - 14. Painting and finishing.
 - 15. General requirements for demonstration of completed systems

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. “Design Equipment”, “Design Make”, “Basis of Design”, and similar terms: Equipment, specified in Technical Specification Section or on Contract Drawings using applicable manufacturer’s designation, that forms the basis for performance requirements, physical dimensions, configuration, electrical connection requirements, and similar aspects used in the design of this Project including (but not limited to) physical configuration of surrounding construction and location of connections to other components.
- G. Specified Equivalents: Products identified in Technical Specification Section that may provide performance complying with specified requirements but may not have the same arrangement, configuration, size, construction, or other aspects as the specified Design Equipment. Refer to Section 00 21 13 - Instructions to Bidders, and Section 01 25 00 – Substitution Procedures for additional information and requirements regarding equivalents and substitutions.
- H. “Equivalents”, “Proposed Equivalents”, “Proposed Products” and similar terms: These terms may be used interchangeably and mean the same thing: Products NOT identified in Technical Specification Section that the Contractor proposes in accordance with Section 00 21 13 - Instructions to Bidders and Section 01 25 00 – Substitution Procedures.
- I. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor, all in accordance with Section 01 25 00 – Substitution Procedures.

1.4 ABBREVIATIONS

- A. Abbreviations: Reference to technical society, organization, body or section made in Division 23 in accordance with the following abbreviations:
 - 1. AIA American Institute of Architects
 - 2. ADA Americans with Disabilities Act.
 - 3. AMCA Air Movement and Control Association International, Inc.
 - 4. ANSI American National Standards Institute
 - 5. ASHRAE American Society of Heating, Refrigerating and Air Conditioning Engineers
 - 6. ASME American Society of Mechanical Engineers International
 - 7. ASTM American Society for Testing and Materials International
 - 8. AWS American Welding Society
 - 9. IEEE Institute of Electrical and Electronics Engineers, Inc.
 - 10. NEC National Electric Code
 - 11. NEMA National Electrical Manufacturers Association
 - 12. NFPA National Fire Protection Association
 - 13. NYBFU New York Board of Fire Underwriters
 - 14. SMACNA Sheet Metal and Air Conditioning Contractors National Association
 - 15. UL Underwriters Laboratories Inc.

1.5 SYSTEM DESCRIPTION

- A. Provide complete systems, properly connected, tested, balanced, adjusted, and ready for operation, including all necessary and required controls, safeties, details and accessories, including (but not limited to):
1. Demolition and removals required for equipment and system installation, including all system fluid and solid components.
 2. Piping systems and related equipment.
 3. Refrigeration systems and related equipment.
 4. Ventilation systems and related equipment.
 5. Support Systems and related equipment.
 6. Insulation Systems and related equipment.
 7. Miscellaneous items required for equipment and system installation.
 8. Controls and electrical control wiring to equipment furnished in this contract.
 9. Electrical power wiring to equipment furnished in this contract, where not covered elsewhere.
- B. HEATING WORK DRAWINGS ARE DIAGRAMMATIC. Do not infer that Drawings show level of detail indicating every offset, elbow, union, fitting, elevation or aspect ratio changes, or other details required for complete installation.
1. Provide all required fittings, offsets, elevation changes, dampers, controls, components, and similar items not indicated on Drawings, as required for a complete properly operational system.

1.6 SUBMITTALS

- A. General Division 23 submittal requirements:
1. Procedural Requirements: Comply with requirements of Section 01 33 00 - Submittals and as modified below.
 - a. Specified Products: If product to be incorporated into Project is the basis of design equipment, and will be installed as specified in Part 3 in the product's technical specification section, and only where allowed as such in submittal portion of product specification, then the "As-Specified Verification Form" (attached to Section 01 33 00 - Submittals) may be used in lieu of "Product Data" identified.
 - b. Do not use "As Specified Verification Form" unless specifically indicated in detailed product specification.
 - c. Equivalent Products or Substitutions: If product proposed to be incorporated into Project is not the basis of design equipment, comply with all Product Data requirements specified.

2. Product Data: Submit Product Data for items listed in individual technical section. Clearly identify manufacturer, pertinent design, function, materials, construction, and performance data specifically addressing specification description and Contract Document requirements of item. Where more than one product is indicated on manufacturer product literature, strike out products that are not applicable to item being submitted, highlight options selected and proposed, and remove extraneous pages of catalogs not being used in the project..
 - a. Cover Sheet: Attach cover sheet, identified in Section 01 33 00, to Product Data of each item submitted. Provide cover sheet for only one type of item with related accessories, equipment with related components. Do not combine unrelated items under same cover sheet.
 - b. Specified Equivalent Product Data: Submit manufacturer's product information including product literature, technical specifications and descriptions, performance data, and similar items to demonstrate compatibility with Basis-of-Design Equipment as specified in "Manufacturers" in Part 2 - Products below.
3. Coordination Drawings: Prepare Coordination Drawings in timely manner to comply with overall construction schedule. Refer to Sections 01 31 00 and 01 33 00 for more details.
 - a. Prepare drawings coordinating HVAC systems, lighting fixtures, ceiling mounted devices, ceiling heights, materials, structural work, maintenance clearances, electric code clearance, building systems, existing construction, etc. Provide additional details and sections, as required for clarity, at all places of potential conflict.
 - b. Deliver Coordination Drawings in accordance with requirements specified in Section 01 31 00. Indicate areas of conflicts between HVAC systems and other building components by highlighting locations on drawings and separately listing.
 - c. Reposition proposed locations of HVAC systems as required to work within project constraints. Adjust exact size, aspect ratio, location and offsets of ducts and pipes as required. Achieve as specified and other reasonable appearance objectives in open areas without ceilings without increase in Contract Sum.
 - d. Review of Coordination Drawings in accordance with Section 01 31 00 does not relieve Contractor from responsibility for coordinating HVAC systems with Project work, nor does it authorize extra cost, omission or deviation from Contract Document requirements. Costs arising from errors or omissions in Coordination Drawings shall be borne by Contractor.
 - e. Review Coordination Drawings and compare them with all other drawings to verify that all Work can be installed without interference. Notify Owner's Project Representative in case of unresolved interferences prior to installation of any work. Revise Coordination Drawings as required to eliminate installation interferences upon direction of Architect.

- f. Do not proceed with installation of systems in each area until agreement is reached with all concerned on exact arrangements for each room or area, unless otherwise directed by Architect. If Contractor proceeds prior to resolving conflicts, Contractor shall modify installed Work as required to permit other systems to proceed with a coordinated installation.
- 4. Specified Equivalent Drawings: Submit detailed drawings of proposed Specified Equivalents, indicating proposed installation of equipment and showing maintenance clearances, required service removal space, and other pertinent revisions to arrangement and configuration shown in Contract Documents.
- 5. Closeout Information, for inclusion in Operations and Maintenance Manual:
 - a. Approved submittals.
 - 1) If “As-Specified Verification Form” submittal is approved, also include product data as specified in technical section for all components used.
 - b. Include all information required in Section 01 78 23 – Operation and Maintenance Data.
 - c. Include all other closeout information required by the individual technical specification sections.
- B. Shop Drawings: Include dimensioned plans, sections, and attachments to other work for concrete bases.
- C. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
 - 1. Power Train Accessories
 - 2. Concrete Bases, Grout
 - 3. Sealants
 - 4. Fire-stopping.
 - 5. Access doors.
 - 6. Painting and finishing.
- D. Samples:
 - 1. Submit color chart with paint manufacturer’s color samples for final color selections prior to beginning painting. Comply with additional requirements for color selection samples specified in Division 09.
- E. Closeout Information, for inclusion in Operations and Maintenance Manual:
 - 1. Approved submittals.
 - a. If “As-Specified Verification Form” submittal is approved, also include product data for all components used.
 - 2. Include all information required in Section 01 78 23 – Operation and Maintenance Data.

3. Letters on manufacturer's letterhead from equipment manufacturers certifying that their equipment and systems have been installed in strict accordance with manufacturer's recommendations, properly aligned and adjusted, tested, lubricated, wired, balanced, etc.
4. Valve, Lubrication, Filter, and Belt / Drive charts as described below.

1.7 QUALITY ASSURANCE

A. Regulatory Requirements

1. Comply with applicable requirements of all Federal, New York State, and Local Building, Health, Mechanical, Plumbing and Electrical Codes, Laws, Ordinances and Regulations, including (but not limited to):
 - a. Building Code of New York State
 - b. Mechanical Code of New York State
 - c. Fire Code of New York State
 - d. Energy Conservation Construction Code of New York State
 - e. New York State Education Department Manual of Planning Standards
 - f. In event of a conflict between the Codes identified above and Contract Documents, comply with more stringent requirement.
2. Comply with applicable requirements of NFPA, utility company regulations, and following standards:
 - a. Provide Underwriters Laboratories (UL) labels on all electrical materials carrying 50 volts or more.
 - b. Provide refrigeration equipment complying with Safety Code for Mechanical Refrigeration (ASHRAE Standard 15 - and ANSI Refrigeration Safety Code B9.1).
 - c. Provide all boilers/burners in accordance with applicable requirements of New York State Labor Department Industrial Code Rule No. 4 (cited as 12 NYCRR4) and Code Rule No. 14 (cited as 12 NYCRR14).

B. Certifications: Obtain and pay for all necessary inspections and certificates from all applicable agencies. Perform all required tests in accordance with regulation of agency having jurisdiction. Submit certificates of approval prior to Final Completion as defined in Section 01 77 00 – Closeout Procedures. Submit certificates of approval prior to request for final acceptance of Contract.

C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified at no additional cost to the Owner. Equipment must continue to comply with the requirements of the Energy Conservation Code applicable to the project.

D. Welding Quality Control for General Construction and Support Work:

1. This paragraph refers to qualifications for General Construction and Support Work welding only. Qualify welders, brazers, and any welding or brazing procedure to be used on piping for this Project in accordance with ASME "Boiler and Pressure Vessel Code", Section IX, as specified and detailed in Section 23 21 13 - Hydronic Piping.
2. Welding and Brazing Procedure Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel." Qualification may be made by technically competent group or agency (subject to approval) meeting the following conditions:
 - a. Group or agency qualifying the procedure meets all procedure qualification requirements of AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - b. Contractor accepts full responsibility for procedure qualified.
 - c. Contractor has qualified at least one welder or welding operator using procedure qualified and provides record of qualification.
 - d. Contractor accepts full responsibility for qualified procedures by signing related qualification records with procedure and performance qualifications including all dates, results, and associated data.
3. Welders' and Brazers' Qualifications: Ensure that all welders, welding operators, brazers, or brazing operators employed for this project are qualified for all welding and brazing procedures, proposed as part of this Project, in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel.". Qualification by previous employer or technically competent group or agency (subject to approval) may be acceptable if following information is included:
 - a. Documentation that the previous qualification was for essentially the same procedures proposed and was in full accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - b. Copy of performance qualification testing record showing who qualified the worker, date of qualification, and work history record showing continuous performance to maintain qualification.
4. Weld and Braze Qualification Records: Maintain and sign certified records of approved procedures used and approved qualified workers employed for welded and brazed joints performed as a part of Prime Contract. Ensure all welding and brazing work can be traced to a specific procedure and welder.
5. Inspection and Examination by Owner, Remedy by Contractor: Owner reserves right to examine, inspect, and test all piping using visual, radiographic, or other recognized testing methods to determine compliance with specified quality control requirements and requirements of applicable regulatory agencies.
 - a. Cost of Owner's testing of acceptable installation provided at Owner's expense.

- b. Repair piping installations not passing Owner's quality inspection testing using approved method or replace at no additional cost.
 - c. Cost of initial testing of piping not conforming to specified requirements and any retesting of repairs or replacement work shall be deducted from Contract Sum.
- E. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Packing and Shipping: Ship materials in manufacturer's containers, fully identified with manufacture's name, trade name, type, class, style, model, grade, size and color.
- B. Storage and Protection
 - 1. Store materials, equipment, fixtures, pipe, fittings, attachments, under cover, off ground in original containers as applicable, and protect from physical and weather damage while in storage and during construction.
 - 2. Furnish extra materials identified in technical sections, in original manufacturer's containers and packaging, to Owner at location identified during Preconstruction Conference. Obtain receipt from Owner upon delivery of extra materials and send copy of receipt to Architect.
 - 3. Replace or repair damaged, rusted, corroded or otherwise unusable materials physically damaged or weather damaged equipment as determined by Architect, at no change in Contract Sum.

1.9 PROJECT/SITE CONDITIONS

- A. Field Measurements
 - 1. DO NOT SCALE DRAWINGS: Refer to Architectural and Structural drawings for dimensions and details, and verify measurements in field before proceeding.
 - 2. Install all items with proper provision for removal and access to coil bundles, boiler tubes, belts, valves, traps, and similar components.
 - 3. Layout of equipment, piping, and similar components in Drawings is diagrammatic. Review Drawings in the field, identify interference with other construction and verify dimensions at Site prior to beginning installation.
 - a. Obtain exact size and location of all items and openings and confirm all existing conditions in field. Review Shop Drawings of all Contracts.
 - b. Coordinate all Heating Work that interferes with other construction with other responsible Contractor.

- c. Obtain exact location and roughing requirements for all equipment furnished by others, but installed by this Contractor before roughing. Owner reserves right to make reasonable changes prior to "roughing-in" without increase in Contract Sum.
- 4. Report any conflicts to Architect in writing before beginning installation.

1.10 SEQUENCING AND SCHEDULING

- A. Perform all Heating Work in cooperation with Owner, Architect, Construction Manager, and all Contractors on this Project, and other separate Contractors at the Site.
 - 1. Coordinate all Heating Work with construction schedule requirements in Division 01
 - 2. Coordinate all submittals with the construction schedule and with requirements and schedules contained in Section 01 33 00 – Submittals Procedures.
 - 3. Immediately report any delays in receipt of materials required for Heating Work including circumstances causing delays.
- B. Existing Construction: Provide openings, chases, recesses, lintels and bucks required for admission of Heating Work, unless otherwise noted. Do not cut waterproofed floors or walls for admission of equipment or materials without written permission. Do not pierce structural members without written permission.
- C. New Construction:
 - 1. Obtain and furnish necessary information, such as locations and sizes of heating construction, fixtures and equipment, to all Contractors in ample time for installation of openings, chases, recesses, lintels and bucks required for admission of project construction, fixtures and equipment.
 - 2. Provide sleeves, inserts, panels, raceways, boxes, and similar components, ahead of schedule required for Heating Work installation and ahead of associated General Work. Provide Heating Work representative during installation of General Work responsible for maintaining items in position.
- D. Supports for Heating Work: Provide anchor bolts required supporting or securing Heating Work. Locate settings and check locations as construction progresses. Provide templates or holding fixtures as required to maintain proper accuracy.
- E. Cutting and Patching: Bear expense of cutting, patching, repairing or replacing of work of all Contracts required due to fault, error or damage by contractor responsible for Heating Work, unless otherwise specified in Contract Documents. Employ and pay Prime Contractor involved, or if there is no associated Prime Contractor, employ and pay qualified subcontractor as required for corrective work.
- F. Refer to Division 01 for cooperation between Contractors. Prior to start of construction:
 - 1. Obtain from Contract Drawings or Architect, exact location of items and openings in construction. Conform to existing conditions in field.
 - 2. Review Shop Drawings of all Contracts.

3. If conflict occurs between Contract Drawings, advise Architect in writing before beginning installation and comply with Architect's directions.
4. Obtain exact location and roughing requirements for equipment furnished by other Contractor or by Owner, but installed by Contractor responsible for Heating Work before beginning roughing.

1.11 COORDINATION

- A. Pre-Installation Conference:
 1. Attend pre-installation conference. Arrange for all subcontractors to be in attendance.
- B. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.
- C. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- D. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."
- E. Coordinate Heating Work with plumbing systems, lighting fixtures, ceiling mounted devices, ceiling heights, materials, structural work, maintenance clearances, electric code clearance, and building systems. Verify that Work of all Contractors can be installed without interference with Heating Work.
- F. Notify Architect in case of unresolved interferences prior to installation of Heating Work.
- G. Adjust exact size, location and offsets of exposed HVAC components to achieve reasonable appearance objectives without increase in Contract Sum.
- H. Testing and Balancing: Cooperate with contractor responsible for Testing and Balancing work as required ensuring complete and proper testing, balancing and adjustment of air and water systems. Refer to Section 23 05 93 – Testing, Adjusting, and Balancing for HVAC, for details.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Equipment – Provide as specified and scheduled with all options as required for full compliance.
- B. Specified Equivalents - If Specified Equivalents (refer to “Definitions” in Part 1 above) are proposed, comply with following requirements:

1. Submit "Specified Equivalent Drawings" as specified in "Submittals" in Part 1 above.
 - a. Provide required changes in design and adjacent construction or equipment at no increase in Contract Sum.
 - 1) Where required, provide larger motors, equipment, additional control devices, valves, fittings, and other miscellaneous equipment necessary for proper operation and provide proper location of roughing and connections to other Contractors.
 - 2) Provide additional motors, starters, power, wiring, and control wiring required.
 - 3) Provide revisions to equipment, wiring, support structure, controls, valves, fittings, and other miscellaneous equipment.
 - 4) Additional Architectural and Engineering work, coordination, and documentation.
 - b. If proposed arrangement for Specified Equivalent is rejected, revise to be compliant and resubmit or submit Basis-of-Design Equipment.
 2. Submit "Specified Equivalent Product Data" as specified in "Submittals" in Part 1 above to demonstrate that proposed Specified Equivalent is equal to or better than Basis-of-Design Equipment with respect to all performance characteristics, including but not limited to durability, individual equipment operating costs, entire interrelated system operating costs, service access, noise levels, vibration levels, compatibility with Owner's other existing equipment to minimize parts inventory, aesthetics where applicable, and similar characteristics.
 3. Do not assume that approval of a specified equivalent submittal implies approval of the installed product. Correct all deviations uncovered during construction and warranty period that result in or are caused by any lower performance characteristic than the specified Basis of Design equipment.
- C. Proposed Equivalents and Substitutions: In addition to requirements described elsewhere in these Contract Documents, all proposed equivalent and substitution products being considered shall be subject to the Specified Equivalent requirements listed above.

2.2 MATERIALS

A. Minimum Material Requirements:

1. Construct potable water systems and equipment according to Plumbing Code of New York State.
2. Provide electrical equipment and systems meeting UL standards and requirements of NEC.
3. Provide UL label on all equipment and material with listing service.

4. Material Flammability:
 - a. Flame spread rating of 25 or less.
 - b. Smoke developed rating of 50 or less.
5. Equipment Verification: Carefully check manufacturer's drawings and specifications as they affect their particular equipment; follow factory instructions for roughing, installation, connection, filling, lubrication, testing, balancing, adjusting, alignment, wiring, and start-up operation.

2.3 MOTOR POWER TRAIN ACCESSORIES

- A. For all new motor installations, whether in new equipment or installed as replacement motors, provide accessories listed below as required for a complete new drive system.
- B. V-Belt Connected Motors: Provided with adjustable slide rail bases, motor sheaves, driven pulleys, and belts sized and applied such that total overhung load on motor shaft extension due to belt tension and motor torque does not exceed maximum overhung load allowed by motor design and construction.
 1. Size and apply pulleys so that total overhung load on motor shaft extension due to belt tension and motor torque will not exceed maximum overhung load allowed by motor design and construction, with minimum 150% safety factor.
 2. Motor and driven pulleys/sheaves to be premium quality, machined cast iron balanced to MPTA standards, tapered bushing bolted shaft connections, variable pitch diameter motor sheave through 10 hp motors (fixed sheaves 15 hp and above), multiple belt grooves and belts 5 hp and above and as required to maintain safety factor.
 3. V-belts to be premium quality oil and heat resistant notched cog type belts with precision molded raw edges in matched lengths as required for application. Provide one extra set belts minimum for each belt drive system, secured adjacent to drive or turned over loose to Owner if so requested.
 4. Provide slide rail base to fit new motor for all new equipment motors, whenever replacement motor has different NEMA frame size from existing, or where specifically called for:
 - a. Slide rail bases to be heavy gauge formed steel, adjustable with single adjusting bolt for belt tensioning, sized to fit motor.
- C. Independently Mounted Direct Driven Load Motor Couplings: Interlocking machined and balanced steel spider locked Molded rubber insert and capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor. Include EPDM coupling sleeve for variable-speed applications.
- D. Provide personnel guards to fit new motor and drive for all new equipment motors, whenever replacement motor and drive do not fit existing guard, or where noted to provide new guard on drawings.

1. Personnel guards shall be of OSHA approved construction surrounding belts, shafts, and pulleys, with tachometer holes for motor and driven shafts.

2.4 CONCRETE BASES AND SUPPORTS

- A. Use 4000-psi f_c air entrained concrete, maximum #1 aggregate, all edges chamfered 1-1/2 inches, trowel finished, and properly consolidated to eliminate voids. Reinforce and secure to floor with #4 rebar dowels 18 inches O.C. 3 to 6 inches from edge around entire perimeter, inserted into structural slab 3 inches minimum and extending to within 1 inch of pad top. Enclose dowels with #4 deformed rebar ring around all dowels overlapped 18 inches minimum and bent in at ends 12 inches minimum, secured to dowels at center of pad height. Roughen structural slab, and coat with cement grout before pour. Ensure all equipment bolt down locations are within reinforcement ring, extended into structural slab as required by seismic considerations.
- B. Set adjustable internal threaded concrete inserts at appropriate bolt-down locations before pouring equipment bases. Use expansion anchors extended into structural slab as required by seismic considerations. If reusing existing concrete base, use expansion anchors. After leveling and anchoring equipment, fill equipment bases with grout as required.
- C. Boiler Bases: 5-1/2 inches thick minimum, reinforced with 6x6-W1.4xW1.4 welded wire mesh, 1-1/2 inches from bottom at boiler rails and doubled over 12 inches on long edges so as to leave 1-1/2 inches cover.
- D. All Other Equipment Bases: 3-1/2 inches thick minimum, reinforced with 6x6-W1.4xW1.4 welded wire mesh, minimum 1-1/2 inches cover, doubled over 12 inches on long edges, unless otherwise specified

2.5 GROUT

- A. Description: ASTM C 1107, Grade B, non-shrink, non-metallic, high strength grout, suitable for interior and exterior, above and below grade applications.
 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 2. Design Mix: 5000-psi, 28-day compressive strength.
 3. Packaging: Premixed and factory packaged.

2.6 SEALANTS

- A. Comply with requirements for sealants in non-fire rated penetrations specified in Section 07 92 00 "Joint Sealants", and also with requirements for Air duct sealants in Section 23 31 00 – Ductwork.
- B. Provide premium products specified for each application as appropriate.

2.7 PENETRATION FIRESTOPPING

- A. Comply with requirements for sealants in fire rated penetrations specified in Section 07 84 13 - Penetration Firestopping.
- B. Submit Manufacturers Product Data Sheets for each type of product selected. Certify that Firestop Material is free of asbestos and lead paint, and complies with local regulations.
 - 1. Certification by firestopping manufacturer that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs) and are nontoxic to building occupants.
- C. Submit system design listings, including illustrations from qualified testing and inspection agency that is applicable to each firestop configuration.
- D. Submit a project specific Penetration Firestopping Schedule indicating where each firestop configuration will be used.

2.8 ACCESS DOORS

- A. Comply with requirements for access doors specified in Section 08 31 13 - Access Doors and Frames for product requirements of access doors in general construction.
- B. Comply with requirements for access doors specified in Sections 23 31 00 – Ductwork and 23 33 00 - Air Duct Accessories for product requirements of access doors in Air Ducts.

2.9 PAINT AND FINISHES

- A. Refer to Division 09 for paint and finish product specifications.

PART 3 - EXECUTION

3.1 EXISTING CONDITIONS

- A. Examine existing conditions in the field prior to beginning demolition or contract Work as required to confirm conditions are appropriate for the work to proceed. Refer to Section 01 73 00 "Execution" and Section 02 41 19 "Selective Demolition" for additional information and general demolition requirements and procedures.
- B. Reuse materials and equipment only as indicated on Drawings. Furnish new equipment and materials in conformance with Contract Documents for all Heating Work, including any material, operation, method or device mentioned, listed or noted within Division 23 Sections, unless reuse is specifically indicated, or unless specified as furnished or installed by Owner, all Contractors, or others.
- C. If pipe, insulation, or equipment to remain is damaged in appearance or is otherwise made unserviceable by adjacent or associated work or error, remove damaged or unserviceable portions and replace with new products of equal capacity and quality. Verify, document, and confirm pre-existing damage with Owner and Architect before beginning work.

3.2 HVAC DEMOLITION

- A. Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed.
1. Prior to removal of system components, provide for proper working conditions including but not limited to:
 - a. Electrically shutdown and/or disconnect with lockout / tag as required.
 - b. Provide Personnel Protection Equipment.
 - c. Air Systems: seal off portions of systems not under construction as required protecting Owner's belongings.
 - d. Hydronic Systems: Properly isolate and drain systems as required protecting Owner's belongings.
 - e. Refrigerant Based Systems: Evacuate and retain refrigerant per ASHRAE 15 and 40 CFR 82.
 2. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material at point of continued use or as otherwise specifically indicated.
 3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and cap remaining ducts with same or compatible ductwork material.
 4. Equipment to Be Removed: Disconnect and remove equipment and all associated accessories. Plug, cap, seal, and otherwise patch to match as required.
 5. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, protect, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational. Document any existing damage before removals.
 6. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- B. Disposition of Removed Components:
1. All material and equipment shown on the drawings to be removed during project Work that is not indicated on the drawings as being either reused or turned over to the Owner becomes the Contractor's property as a part of the project including salvage value and legal disposal cost complete.
 2. For components that become the Contractor's property through this removal process: Confirm transfer of ownership in writing then promptly remove from the site and legally process.
 3. For components indicated on the drawings to be turned over to the Owner: deliver to a project site location designated by the Owner.
 4. For components indicated on the drawings to be reused: carefully remove, protect, and store until appropriate time for re-installation. Document any pre-existing damage prior to removals.

5. For pipe and tubing indicated to be reused, reuse only those portions of pipe, tubing, and associated fitting assemblies where they are direct replacements of the as specified and as shown new piping assemblies. Valves, strainers, other piping specialties, and insulation shall not be re-used unless specifically indicated on drawings.

3.3 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.
- E. Ensure each equipment manufacturer:
 1. Carefully checks Contract Drawings and Specifications applicable to manufacturer's equipment before roughing.
 2. Reports to Architect, before or when Shop Drawings are submitted, any discrepancies or conditions applied to manufacturer's equipment that prevents proper functioning, servicing, and other aspects of equipment operation.
 3. Provides manufacturer's printed installation instructions for each piece of equipment.
 4. Thoroughly instructs Contractor exactly how equipment should be installed, connected, lubricated, started, operated, and similar aspects to ensure all factory instructions are rigidly followed during installation of equipment.
- F. Install, test, start, and operate equipment as instructed by manufacturer.
- G. Submit written evidence from equipment manufacturer that manufacturer's equipment and systems have been:
 1. Installed in strict accordance with manufacturer's recommendations.
 2. Properly aligned and adjusted, tested, lubricated, wired, balanced, and similar operations
- H. Equipment Connections
 1. Provide final make up water, condensate, heating water, drain, vent, and refrigerant to all equipment as required.
 2. Provide isolation valves and flanges or unions on the supply and return piping connections to all equipment arranged as required for reasonable service isolation and access.

3. Provide equipment waste, drip, overflow, bleed water, condensate, and drain connections extended to floor or roof drains or other approved points of discharge. Provide integral condensate pumps and appropriate piping for units where gravity condensate drain is not practical or possible.
 4. Provide for Owner-furnished equipment. Refer to manufacturer's drawings and specifications for requirements of Owner-furnished equipment and verify connection requirements.
 5. Connect equipment complete and ready-to-use, including all valves, piping, piping accessories, traps, pressure reducing and backflow prevention devices, gauges, relief valves, vents, drains, insulation, sheet metal work, controls, dampers, and similar components required.
- I. Precautions Against Freezing: In addition to applicable requirements in Division 01 and individual technical sections, take all necessary precautions with equipment and systems to prevent damage to building, piping, equipment, and other components due to freezing and water leakage until final acceptance. Before freezing weather occurs, make certain all:
1. Safety features are properly functioning.
 2. Freeze protection is tested and sensing elements are properly located.
 3. Openings around outside grilles, louvers, and similar items are properly sealed; notify Architect in writing if openings are not adequately sealed.
 4. Outside air dampers are tight fitting and operational, and damper motors are properly winterized.
 5. Air systems are properly balanced.
 6. Proper insulation is installed where required.
- J. Concealment: Conceal all Work not specifically shown on the Drawings as exposed. Note piping risers may be shown outside of walls due to scale of drawing symbols – the general intent is for these pipes to be concealed within the general construction if possible or if not possible, to be within riser chases. If for any reason concealment is impossible, notify the Architect and obtain written approval before starting that part of the Work.
- K. Exposed Items: Install exposed items as shown on Drawings or as approved by Architect. Obtain Architect's approval for final arrangement and appearance before installing items in areas without ceilings.
- L. Damaged Components and Replacement: If pipe, duct, insulation, or any HVAC component or equipment is damaged in appearance or is otherwise unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.
- 3.4 ERECTION OF SUPPORTS AND ANCHORAGES
- A. Provide a complete system of support and anchorage for all Contract work.
- B. Refer to Section 23 05 29 - Hangers and Supports for HVAC Components, Section 23 05 43 – Mechanical Vibration and Movement Control, and Division 05 and Division 06 complete for detailed additional requirements.

3.5 CONCRETE BASES

- A. Provide concrete bases for all floor-mounted HVAC systems equipment, unless specifically indicated otherwise in Contract Documents.
 - 1. Shape and size to accommodate equipment, with minimum of 6 inches clear pad all around perimeter unless otherwise required by equipment manufacturer.
 - 2. Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic requirements of Project. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with anchorage.

3.6 GROUTING

- A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

3.7 MECHANICAL PENETRATIONS, WATERPROOFING, AND SEALING

- A. Openings Through Roofs: Curbs are required for rooftop air handling equipment, ventilators, fans, piping penetrations, etc. Roofing, flashing, and general waterproofing are the responsibility of the Contractor unless specifically indicated otherwise elsewhere in the Contract Documents. Refer to Architectural Drawings for related work by others.
 - 1. Use factory pre-fabricated units as specified and noted on Drawings.
 - 2. Caulk and waterproof neatly with additional material as required.
 - 3. Employ the services of an approved roofing sub-contractor for all patching and/or new work indicated as part of the Heating Work.
 - 4. Any roofing work performed under this Contract shall be performed in such a way as to not void any existing roofing warrantee. Additionally, whether there is a roofing warrantee currently in force or not for roof in area of new penetrations, all new penetration work shall be warranted leak free for a period not less than one year from final acceptance of project.
 - 5. Provide structural support for roof deck around all roof curbs and roof deck penetrations larger than 12 inch x 12 inch, unless specifically indicated otherwise elsewhere on the Contract Documents.

B. Opening Through Outside Walls:

1. Guarantee all penetrations to be thoroughly air and watertight. Caulk and flash duct penetrations in accordance with specifications, details on Drawings, and as required.
2. Install louvers in accordance with specifications, manufacturer's recommendations, and details, as required to achieve guaranteed air and watertight penetrations. Direct drainage to drip away from building surface.
3. Use special waterproof construction as directed.
4. Provide mechanical sleeve seals for piping penetrations.
5. Provide structural support for wall above all penetrations wider than 12 inches, unless otherwise indicated elsewhere on the Contract Documents.
6. Below grade openings:
 - a. Provide mechanical sleeve seals for piping penetrations.
 - b. Seal duct penetrations by filling space between duct and sleeves with approved non-hardening caulking compound. Openings to be caulked from inside and outside, before back filling.
 - c. Seal below grade insulation system water tight to building foundation wall in accordance with insulation manufacturer's printed recommendations.

C. Openings Through Floors and Inside Walls: Provide through penetration systems for all mechanical work floor and wall penetrations which do not compromise the integrity of the floor or wall with regards to fire rating, smoke passage rating, acoustical noise reduction rating, or seismic rating. Insure through penetration system does not transmit mechanical vibrations to building walls or floors. Seal all floor penetrations to effectively block the passage of smoke and fumes.

1. Provide structural support for floor deck around all penetrations larger than 12 inches in any dimension, unless specifically indicated otherwise elsewhere on the contract documents.

3.8 FIRESTOPPING

- A. Provide Through-Penetration Firestopping Systems and Devices listed in UL Fire Resistance Directory under categories XHCR and XHEZ and conforming to construction type, penetrant type, annular space requirements and fire rating indicated or required for each application.
- B. Provide systems that withstand passage of cold smoke either as inherent property of system or by use of separate product included as part of UL system or device designed to perform this function.

3.9 ACCESS DOORS

- A. Provide all access doors shown on Drawings and as required for access to motors, dampers, valves, controls and all other devices requiring periodic inspection, adjustment or maintenance where located above or within inaccessible walls or ceilings except where access doors are indicated to be provided by others.
- B. Engage skilled tradesman experienced in installation of access doors in applicable types of adjacent construction to install access doors. Install in accordance with requirements of Division 08 Section on access doors.
- C. New Construction: Coordinate size and locations of openings required for access panels in walls, floors and ceiling construction with General Work Contractor in ample time for installation of access panels.
- D. Existing Walls, Floors, and Ceilings: Cut and patch to install access doors in conformance with Section 01 73 00 - Execution.
- E. Ductwork: Provide all access doors as required by Sections 23 31 00 – Ductwork and 23 33 00 – Air Duct Accessories.

3.10 PAINTING

- A. Painting of HVAC systems, equipment, and components is additionally specified in Division 09 Sections on Painting.
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.
- C. Vary initial and final coat colors slightly as required to provide positive identification between coats. Do not proceed with final coat until initial coat is properly cured per manufacturer's instructions, and has been approved as complete by Owner's Project Representative. Final coat shall completely conceal initial coat(s).
- D. Paint Requirements:
 - 1. Provide painted finish for HVAC components (exposed equipment, piping, duct, supports and insulation in particular) exposed to view in finished spaces such as gymnasiums, classrooms, offices, corridors, etc. Provide factory painted finishes as specified elsewhere or if not factory painted then field painted. Refer to Division 09 for painting specifications and additional painting requirements if required.
 - a. Provide touch up painting as required to repair, or replace as directed, damaged factory finishes of HVAC components.
 - 2. Paint all exposed metal surfaces that will be above 150 degrees F when in operation, with two coats of heat resistant paint.
 - 3. Paint all miscellaneous fabricated ferrous supports complete.

4. Paint all ferrous piping and components located outdoors as specified in Division 09, except where insulation is to be applied over piping or component.
5. For piping that will be subject to moisture induced corrosion on the exterior of the piping, provide one full coverage coat of corrosion inhibitor equal to "Polyguard RG-2400" on the following ferrous (steel) piping and fittings before insulation is applied:
 - a. All exterior ferrous piping.
 - b. All ferrous piping where the fluid in the piping operates at below ambient conditions (all cooling piping)
 - c. All below grade ferrous piping.
6. Do not paint
 - a. Chrome plated materials, aluminum and brass valves, or brass trim on iron body valves, stainless steel materials, copper indirect waste piping, laboratory waste and vent piping.
 - b. Piping above finished ceiling spaces, except un-insulated ferrous piping and supports.
 - c. Exposed copper pipe, brass valves, or brass trim on iron body valves, or machinery or equipment with factory-applied finish, unless otherwise specified.
7. Coating Systems: Comply with application and material requirements specified in Division 09.

3.11 PROTECTION

- A. Maintain systems during construction, temporary use, and until acceptance by Owner.
 1. Properly lubricate all HVAC systems bearings during use.
 2. Maintain limit controls, overload devices, and safety controls in operating condition during use

3.12 ALTERATIONS

- A. Provide protection of existing facilities, demolition and removals, replacement and restoration, including patch-to-match requirements, and hazardous materials procedures to install Heating Work in conformance with Division 01 requirements.
- B. Provide cutting and patching required to install Heating Work in accordance with the requirements of Division 01 covering cutting and patching.

3.13 ADJUSTING AND CLEANING

- A. Adjust all work as required to insure systems perform as designed and as intended, including but not limited to the following:

1. Adjust all registers and diffusers to insure even air distribution free of objectionable drafts. Include all new and all existing to remain registers and diffusers on systems where HVAC modifications are made.
 2. Adjust all hangers and supports to insure proper piping slope, alignment of flexible connections, even loadings, proper venting and draining, proper control over thermal expansion, etc.
 3. Adjust all mechanical equipment insuring it runs properly as intended, providing the performance specified and required, and as required to maintain all warranties.
- B. Clean work furnished or provided as part of Heating Work, including but not limited to equipment, control panels and devices.
1. Refer to and comply with Section 01 50 00 - Temporary Facilities and Controls for additional requirements for cleaning during construction and Section 01 77 00 – Closeout Procedures for additional requirements for final cleaning.
 2. Remove debris, leftover piping, tubing, metal, insulation, cartons, papers, etc., resulting from Heating Work.
 3. Remove all rust, dirt, oil, etc. from Heating Work to be painted and maintain in condition ready for painting.
 4. Clean inside and outside of all equipment and distribution systems provided including (but not limited to) following:
 - a. All enclosures.
 - b. Remove all rust, oils, and similar contamination from all equipment, piping and supports to be painted, and leave components ready for painting.
 - c. Remove debris, leftover piping, wiring, tubing, metal, insulation, cartons, papers, and similar items left in building or on Site. Clean building as often as necessary and when directed by Architect.
- C. Final Cleaning: In addition to requirements specified in Section 01 77 00 – Closeout Procedures and other sections in Division 23, provide following measures.
1. Where heating units have been used to provide temporary heat, clean all permanent filters, replace all disposable filters, and clean all ducts, blowers, and coils.
 2. Clean all piping strainers and replace all "startup" screens with permanent screens.
 3. Refer to Section 23 01 20 – Hydronic Systems Cleaning and Water Treatment for detailed specifications on hydronic systems cleaning.
 4. Provide written notification to Architect upon completion of all final cleaning procedures and request inspection of final cleaning.

3.14 DEMONSTRATION OF COMPLETED SYSTEMS:

- A. Prior to Final Completion, thoroughly demonstrate and instruct Owner's designated representatives in care and operation of all heating and ventilating systems and equipment provided in Heating Work. Provide necessary skilled labor to operate all systems for not less than 5 days and provide required instruction.
1. In addition to Contractor's instruction, arrange for technically qualified factory representatives to train Owner's designated representatives in care, maintenance, and operation of following manufacturer's equipment and systems.
 - a. Temperature controls.
 - b. Central station air handling equipment and units.
 - c. Boilers / Burners.
 - d. Energy recovery equipment.
 - e. Air conditioning units and equipment.
 - f. Fire suppression systems.
 - g. Variable speed drives.
 2. Coordinate and schedule time and place of all training through Architect at Owner's convenience.
 3. Submit letters verifying satisfactory completion of all instruction including date of instruction, names of persons in attendance and countersigned by authorized representative of Owner.
 4. Until final acceptance, Contractor retains full responsibility for systems operations and maintenance, even though operated by Owner's personnel during instruction, unless otherwise agreed to in writing.
 5. During instruction, provide list, sealed in clear plastic, outlining operating, maintenance, and starting precautions and procedures to be followed by Owner for operating systems and equipment.
- B. Valve Identification Chart: Provide a valve chart for all valves installed in contract.
1. Provide 8-1/2 inch x 11 inch minimum size Valve Identification Chart, typed in capital letters, mounted under clear laminated plastic; secure to wall where directed.
 2. Valve Numbering System: Extension of and compatible with existing valve numbering system, where valves are installed in existing building or in addition to existing building. Do not duplicate existing numbers; verify existing numbers in the field.
 3. List all valves included in Contract. Obtain necessary information containing the following:
 - a. Valve number, piping system, system abbreviation (as shown on valve tag) and location of valve.
 - b. Normal operating position (open, closed, or modulating).
 - c. Clearly identify special purpose valves (for emergency shutoff, etc.).

- C. Lubrication Chart: Provide minimum 8-1/2 inch x 11 inch lubrication chart for all Work in Heating Work Contract, typed in capital letters, mounted under clear laminated plastic, and secured to wall where directed by Architect.
1. List all motors and equipment including following information:
 - a. Name and location of equipment.
 - b. Type of lubrication recommended by manufacturer.
 - c. Lubrication period recommended by manufacturer.
 2. Lubricate all motors immediately after installation and perform lubrication maintenance until final acceptance by Owner.
- D. Air Filter Chart: Provide an air filter chart for all equipment installed in contract.
1. Chart shall be 8-1/2 inch x 11 inch minimum size, typed in capital letters, mounted under clear laminated plastic; secure to wall where directed.
 2. List all equipment that includes filters in Contract. Obtain necessary information containing the following:
 - a. Name and location of equipment
 - b. Type of filters recommended by the manufacturer.
 - c. Size of filters for each piece of equipment.
 - d. Recommended replacement schedule from unit manufacturer.
- E. Belt / Drive Chart: Provide a Belt / Drive chart for all motorized equipment installed in contract. May be combined with lubrication chart above.
1. Chart shall be 8-1/2" x 11" minimum size, typed in capital letters, mounted under clear laminated plastic; secure to wall where directed or turned over in binder.
 2. List all motor driven equipment in contract. Obtain necessary information containing the following:
 - a. Name and location of equipment.
 - b. Type of drive – belt, direct, flex coupling, etc.
 - c. Drive data as applicable:
 - 1) Size and number of belts with replacement belt mfg., model, part numbers.
 - 2) Size of drive and driven pulleys, mfg., model, part numbers.
 - 3) Flexible coupling mfg., model, part numbers.

END OF SECTION 23 05 00

SECTION 23 05 13 - COMMON ELECTRICAL REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes:
 - 1. General requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.
 - 2. Starters and drive train accessories for electric motors.
 - a. Refer also to Section 23 29 00 for Variable Frequency Motor Controllers.
 - 3. Electrical auxiliary components required for HVAC systems that are not specifically identified in "E" series Drawings or Division 26.
 - 4. Electrical wiring required for HVAC systems that is not specifically identified in "E" series Drawings or Division 26.

1.3 SUBMITTALS

- A. General: Submit all action submittals required by this Section concurrently.
- B. Action Submittals:
 - 1. Product Data: For each type of product indicated, demonstrating compliance with all specified performance and construction characteristics.
- C. Closeout Submittals:
 - 1. Installation, Operation, and Maintenance Data: For motors, drives, electrical power components, and heat trace - include in operation and maintenance manuals.
 - a. Wiring Diagrams: Employ competent technical aid to prepare composite wiring diagrams for field wiring of power, signal, and control wiring for all equipment and systems installed as part of the HVAC Work. Deliver diagrams to proper parties in time for roughing of conduit and equipment connections. Clearly indicate all items to be mounted or wired as part of DIVISION 26. Include as built wiring diagrams in O&M manual.

1.4 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

- A. Manufacturers: Provide products by one of following manufacturers or equal, except where unusual configurations involving frame, hermetic seals, shaft, bearing, or starting characteristics are peculiar to particular item of equipment as specified by Architect:
 - 1. National Resource Management (NRM).
 - 2. Baldor.
 - 3. General Electric.
 - 4. U. S. Motors.
- B. Provide all motors required for the work of Division 23 specifications. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or individual technical specification sections.
- C. Provide all motors suitable for operation at the frequency, voltage, and phasing of the building power.
- D. Provide motors 1/2 HP and larger and motors indicated as driven by variable speed drives, designed for operation on 3-phase power, voltage as shown on electrical plans, +/- 10 percent, unless specifically indicated otherwise on drawings.
- E. Provide constant speed motors 1/3 HP and smaller designed for operation on single phase, 120 volts +/- 10 percent.
 - 1. Unless the equipment has ECM motors and they could be higher than 1/3 HP.
- F. Comply with NEMA MG 1 unless otherwise indicated.
- G. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS AND APPLICATIONS

- A. Provide each motor suitable for continuous duty operation at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level, and suitable for speed, enclosure, rating, type and horsepower not less than as scheduled or specified in Contract Documents. Provide motor enclosure and maximum allowable temperature rise in degrees Centigrade over 40 deg. C ambient as follows, unless otherwise specified:

1. General Purpose: Drip-proof 40 deg. C or encapsulated design 60 deg. C.
 2. Below grade level, roof-top unit, damp, high humidity, or condensing applications: Totally enclosed fan-cooled 50 deg. C or drip-proof encapsulated design 60 deg. C.
 3. Motors, wiring, and disconnects installed in potentially flammable atmosphere: UL listed, NEC rated explosion proof construction, fan-cooled 50 deg. C rise.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
- C. Each equipment manufacturer is responsible for ensuring motors supplied with manufacturer's equipment are fully compatible with the application and capable of starting and running driven equipment without undue noise, heating, or distress.

2.3 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
1. Permanent-split capacitor.
 2. Split phase.
 3. Capacitor start, inductor run.
 4. Capacitor start, capacitor run.
 5. Electronically Commutated Motor (ECM)
- B. Motors 1/20 HP and Smaller: Shaded-pole type.
- C. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- D. Variable Speed Motors: Electronically commutated motor (ECM) shall be of permanent magnet, brushless DC premium efficiency design with variable speed electronic controller capable of maintaining constant speed, torque, and/or cfm as required by service, capable of accepting 0-10vdc or 4-20mA speed control signal from building management system. Adjustable slow start and gradual speed changes, permanently lubricated ball bearings, and extra quiet operation are all included.
- E. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- F. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

2.4 POLYPHASE MOTORS

- A. Single Speed General Application Motors:
1. NEMA MG 1, Design B, medium induction motor.

2. Efficiency: Premium efficiency, as defined in NEMA MG 1.
3. Service Factor: 1.15.
4. Random-wound, squirrel cage rotor.
5. Re-greasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
6. Insulation: Class F.
7. Temperature Rise: One class below insulation rating.
8. Motors 15 HP and Larger: NEMA starting Code F or Code G.
9. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
10. Enclosure Material: Manufacturer's standard rolled steel or cast iron enclosures corresponding to NEMA rating and application requirements.

B. Multi-Speed General Application Motors:

1. Similar to single speed motor requirements above, with separate winding for each speed.
2. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

C. Motors Used with Variable Frequency Controllers:

1. Motors shall meet all other requirements of this document, the driven equipment manufacturer, and the Variable Frequency Controller manufacturer, and be rated for this service with the drive and voltage intended. Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
2. All three phase motors for use with variable frequency controllers shall be special application, inverter duty premium efficiency motors of cast iron construction.
3. Ratings shall be in accordance with NEMA MG-1, Part 31 requirements for the specific application.
4. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
5. Class B temperature rise; Class F insulation.
6. Thermal protection via one Class F thermostat per phase, NEMA MG 1 compliant with requirements for thermally protected motors.

D. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 MOTOR ACCESSORIES

- A. For all new motor installations, whether in new equipment or installed as replacement motors, provide accessories listed below as required for a complete new drive system.

- B. V-Belt Connected Motors: Provided with adjustable slide rail bases, motor sheaves, driven pulleys, and belts sized and applied such that total overhung load on motor shaft extension due to belt tension and motor torque does not exceed maximum overhung load allowed by motor design and construction.
1. Size and apply pulleys so that total overhung load on motor shaft extension due to belt tension and motor torque will not exceed maximum overhung load allowed by motor design and construction, with minimum 150% safety factor.
 2. Motor and driven pulleys/sheaves to be premium quality, machined cast iron balanced to MPTA standards, tapered bushing bolted shaft connections, variable pitch diameter motor sheave through 10 hp motors (fixed sheaves 15 hp and above), multiple belt grooves and belts 5 hp and above and as required to maintain safety factor.
 3. V-belts to be premium quality oil and heat resistant notched cog type belts with precision molded raw edges in matched lengths as required for application. Provide one extra set belts minimum for each belt drive system, secured adjacent to drive or turned over loose to Owner if so requested.
 4. Provide slide rail base to fit new motor for all new equipment motors, whenever replacement motor has different NEMA frame size from existing, or where specifically called for:
 - a. Slide rail bases to be heavy gauge formed steel, adjustable with single adjusting bolt for belt tensioning, sized to fit motor.
- C. Provide personnel guards to fit new motor and drive for all new equipment motors, whenever replacement motor and drive do not fit existing guard, or where noted to provide new guard on drawings.
1. Personnel guards shall be of OSHA approved construction surrounding belts, shafts, and pulleys, with tachometer holes for motor and driven shafts.
- D. Direct connected motors: provide with flexible couplings if required by application and OSHA approved belt guards surrounding rotating machinery.

2.6 STARTERS

- A. Manufacturers: Provide all starting equipment and control devices manufactured by same manufacturer and furnished through single responsible supplier unless otherwise specified in Contract Documents. Factory-wired or assembled packaged equipment may be provided with starting equipment of any acceptable manufacturer. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Cutler-Hammer
 2. General Electric
 3. Square D

- B. Provide starters, contactors, and controllers complying with applicable NEMA standards, minimum size 0, and enclosed in enclosures of type appropriate for environment where installed including general purpose, explosion proof, weather resistant, or weather-tight construction as required.
- C. Ensure all parts subject to wear, arcing, and similar use are easily removable.
 - 1. Provide necessary auxiliary contacts for each starter subject to electrical interlock or automatic control.
 - 2. Equip magnetic starters for motors operating 208 volts and over, line-to-line, equipped with self-contained light loads imposed thereon with a control transformer having a 120-volt grounded secondary winding, and having 120-volt starter operating coils.
- D. Provide combination-type magnetic starters with fused disconnect switches. Fuse with class R fuses. Protect all starters with manual reset, solid state overload relay equal to (Square "D" motor logic) in one leg of single phase line to neutral circuits, in two legs of single phase line-to-line circuits, and in three legs of 3-phase circuits.
- E. Provide 6-volt, red pilot light, integral transformer and long life bulb for all starters and contactors.
- F. Manual Starters: Toggle operated, single pole for line to neutral circuits, two pole for line-to-line circuits, with thermal overload devices and neon pilot light; flush mounted unless shown otherwise, ganged with selector switch for multispeed applications. Provide manual starters similar to one of the following:
 - 1. General Electric CR-101
 - 2. Cutler-Hammer 9101
 - 3. Square D Class 2510
- G. Combination Magnetic Starters: Single speed, across the line, HAND-OFF-AUTO selector switch in cover. Provide combination magnetic starters similar to one of the following:
 - 1. Cutler-Hammer 9589
 - 2. General Electric CR-107
 - 3. Square D Class 8538
- H. Magnetic Contactors: With control coil in series with temperature controls as required.
- I. Refer to Section 23 29 00 – VARIABLE FREQUENCY MOTOR CONTROLLERS for requirements of these devices.

2.7 COMPONENTS

- A. Electrical Wiring: Provide all materials conforming to NEMA Standards and UL approved for intended service. Refer to appropriate sections in Division 26.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Examine conditions under which materials and methods are to be installed and notify Architect in writing of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in acceptable manner.
 - 1. Installation indicates conditions are acceptable to Contractor as required to ensure requirements for applicable warranty or guarantee can be satisfied.
 - 2. Motors and Starters: Confirm electrical characteristics for all equipment.
 - 3. Electrical Wiring: Check all electrical wiring associated with equipment for compliance with specifications and correctness of connections. Correct wiring in event equipment or devices fail to function in specified manner, whether due to incorrect connections or improper information and wiring diagrams.
- B. Inspect and perform tests on project electrical wiring, including infrared scans (thermography), resistance testing, or other industry standard testing as required to demonstrate acceptable wiring. Owner reserves the right to provide their own additional similar testing:
 - 1. Cost of Contractor's testing included in bid price. Cost of Owner's testing of acceptable installations provided at Owner's expense.
 - 2. Repair installations not passing Contractor's or Owner's quality inspection testing using approved method or replace at no additional cost.
 - 3. Cost of initial testing of wiring not conforming to specified requirements and any retesting of repairs or replacement work deducted from Contract Sum.

3.2 INSTALLATION

- A. Motors and Starters
 - 1. Correct, at no additional cost, any misapplied motor or starter combination and improper thermal overload devices for motor starters provided as part of HVAC systems or components, along with damage to other equipment or construction.
 - 2. Motors: Provide motors furnished by equipment manufacturer, specifically manufactured or selected for equipment served; mounted, and installed to provide complete installation that is substantially noiseless in performance under intended use. Replace motors unsatisfactory to Architect with new motor.
 - 3. Starters and Accessories
 - a. Provide starters and disconnects for all HVAC equipment. Refer to Equipment Schedules.

- b. Furnish properly tagged and identified devices specifically indicated on "Electric Equipment and Control Schedule" as supplied by HVAC systems suppliers and determine coordinated location and time for delivery of devices.
- c. Provide auxiliary contacts required for temperature controls, interlock with other equipment, alarms, and similar components and applications.

B. Motor Accessories

- 1. Pulleys and Sheaves: Install on shaft with anti-seize compound and new locking drive keys and setscrews as applicable. Align drive and driven pulleys to within +/- 0.03 inches axially and to within +/- 2 degrees angular misalignment. Install locking devices with anti-vibration locking compound.
- 2. Belts: Install belts and adjust to the manufacturer's recommended tension.
- 3. Personnel Guards: secure to equipment such that belts and pulleys / sheaves are free to rotate and personnel are protected from moving parts.

C. Miscellaneous Electrical Wiring included in HVAC systems installations:

- 1. Provide all control wiring and power wiring for all equipment and associated control devices (including automatic control system) required for HVAC systems and components.
- 2. Comply with all applicable NEC requirements. Install all electric wiring in accordance with all local and state codes and regulations having jurisdiction.
- 3. Wiring for Controls: Provide wiring specified in Section 23 09 00 – Instrumentation and Control for HVAC, for all control devices required for temperature control system and other miscellaneous controls not included in "Electrical Equipment and Control Schedule".
- 4. Allow sufficient headroom under equipment as directed for each location (unit heater, etc.). Verify space available for each equipment item. Refer to Architect for any correction, discrepancy or suggested change in size of location.
- 5. Secure all equipment and fixture mountings, wiring devices, and accessories (clips, supports, etc.) to structure with screws, bolts, or similar items; nailing not acceptable.

END OF SECTION 23 05 13

SECTION 23 05 19 - METERS AND GAUGES FOR HVAC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Liquid-in-glass thermometers.
 - 2. Light-activated thermometers.
 - 3. Thermowells.
 - 4. Dial-type pressure gauges.
 - 5. Gauge attachments.
 - 6. Test plugs.
 - 7. Test-plug kits.

1.3 SUBMITTALS

- A. Procedural Requirements: Comply with requirements of Section 01 33 00 - Submittals and as modified below.
 - 1. Specified Products: If product to be incorporated into Project is specified by name and product designation in Part 2 below, submit “**As-Specified Verification Form**” (attached to Section 01 33 00 - Submittals) in lieu of “Product Data” identified below in this Article.
 - 2. Equivalent Products or Substitutions: If product to be incorporated into Project is not specified by name and product designation in Part 2 below, comply with all Action Submittal requirements specified below.
- B. Action Submittals:
 - 1. Submit all action submittals required by this Section concurrently.
 - 2. Product Data: For each type of product indicated, demonstrating compliance with specifications. Include schedules of locations and ranges proposed.
- C. Closeout Submittals:
 - 1. Approved submittal.
 - a. If “**As-Specified Verification Form**” submittal is approved, also include product data for all valves used.

2. Include all information required in Section 01 78 23 – Operation and Maintenance Data for all meters and gauges used. Include wiring diagrams for meter power, signal, and control wiring.

1.4 EXTRA MATERIALS

- A. Furnish extra materials that match products specified and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Provide one complete test plug kit with training as described below. Include receipt signed by Owner's representative in closeout documentation.

PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS

- A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Terrice, H. O. Co.
 - b. Weiss Instruments, Inc.
 - c. WIKA Instrument Corporation - USA.
 - d. Winters Instruments - U.S.
 2. Standard: ASME B40.200.
 3. Case: Cast aluminum; exterior grade powder coated finish, 9-inch nominal size unless otherwise indicated.
 4. Case Form: Adjustable angle unless otherwise indicated.
 5. Tube: Glass with magnifying lens and non-mercury blue or red organic liquid.
 6. Tube Background: Non-reflective with permanently etched scale markings graduated in deg F.
 7. Window: plastic.
 8. Stem: Bare aluminum of length to suit installation.
 9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
 10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.2 LIGHT-ACTIVATED THERMOMETERS

A. Direct-Mounted, Light-Activated Thermometers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Terice, H. O. Co.
 - b. Weiss Instruments, Inc.
 - c. WIKA Instrument Corporation - USA.
 - d. Winters Instruments - U.S.
2. Case: Plastic or metal; 9-inch nominal size unless otherwise indicated.
 - a. Provide with remote mounting option where needed for reading from casual service location.
3. Scale(s): Deg F and deg C.
4. Case Form: Adjustable angle.
5. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
6. Stem: Aluminum and of length to suit installation.
 - a. Design for Air-Duct Installation: With ventilated shroud.
 - b. Design for Thermowell Installation: Bare stem.
7. Display: Digital, LCD, minimum 3/8 -inch text height.
8. Accuracy: Plus or minus 2 deg F.

2.3 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing or Steel Piping: solid machined de-zincification resistant brass or stainless steel.
4. Type: Stepped shank unless straight or tapered shank is indicated.
5. External Threads: ASME B1.20.1 pipe threads, size as required for sensors.
6. Internal Threads: ASME B1.1 screw threads, size as required for sensors.
7. Bore: Diameter required to match thermometer bulb or stem.
8. Insertion Length: Length required to match thermometer bulb or stem.
9. Lagging Extension: Include on thermowells for insulated piping and tubing.
10. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

- B. Heat-Transfer Medium: Mixture of graphite and glycerin unless otherwise required by sensor manufacturer.

2.4 PRESSURE GAUGES

A. Direct Mounted, Dial Type Pressure Gauges:

1. 4-1/2-inch diameter flat white dials with black characters and graduations, micrometer style or externally adjustable zero point, providing 0.5 percent accuracy at mid scale and 1.0 percent accuracy full scale, certified to ANSI (ASME) B40.100 grade 1A with scales reading in psig.
2. Direct drive helically wound inconel bourdon tube movement with sapphire jeweled bearings or liquid filled stainless steel rotary type movement, rated for pump-mounted service, with bourdon tubes of seamless phosphor bronze alloy with silbrazed tips and forged brass sockets.
3. Impact resistant ABS, drawn steel or cast aluminum case with blow out grommet, snap ring, and “shatterproof” acrylic lens.
4. Provide ranges to read maximum design pressure at between 1/2 and 3/4 of maximum range.
5. Provide combination vacuum pressure gauges where indicated or required.
6. Provide 1/4-inch NPT connections located at bottom, lower back, or center back as required.
7. Provide five-year warranty.
8. Products: Provide one of the following:
 - a. “TLG” by 3D Instruments or equal
 - b. Ashcroft Duradrive model 1290 or equal
 - c. Wika 232.34DD series or equal.

2.5 GAUGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with, ASME B1.20.1 pipe threads and piston or porous-metal-type surge-dampening device. Include extension for use on insulated piping.
- B. Valves: De-zincification resistant brass, bronze, or stainless-steel needle type, slow opening, bubble tight shutoff, with ASME B1.20.1 pipe threads.

2.6 TEST PLUGS AND ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. 3D instruments Inc.

2. Flow Design, Inc.
3. Peterson Products Co
4. Trerice, H. O. Co.
5. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
6. Weiss Instruments, Inc.

B. Test Plugs:

1. Description: Test-station fitting made for insertion into piping tee fitting.
2. Brass or stainless steel body, NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread with Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber core inserts and gasketed and threaded cap with retainer. Include extended stem on units to be installed in insulated piping.
3. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

C. Test-Plug Kits

1. Furnish one test-plug test kit containing two thermometers, one pressure gauge and adapter, and carrying case. Thermometer sensing elements, pressure gauge, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.
2. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F.
3. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F.
4. Pressure Gauge: One pressure gauge as specified above with insertion type adapter probe. Dial range shall be 0 to 100 psig.
5. Carrying Case: Metal or plastic, with formed instrument padding.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 INSTALLATION

- A. Install meters and gauges adjacent to machines and equipment in easily readable position but protected locations to allow and facilitate service and maintenance of meters, gauges, machines, and equipment.

- B. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees. Provide thermometer stems of length to match thermowell insertion length.
- C. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes. For pipe sizes 1 inch and smaller, increase pipe size by one size at location of thermowell to minimize obstruction.
- D. Install thermowells with extension on insulated piping. Insulate fitting past piping well and neatly terminate insulation at thermometer body minimizing heat loss while allowing for adjustment.
- E. Fill thermowells with heat-transfer medium.
- F. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- G. Install direct-mounted pressure gauges in piping tees with pressure gauge located on pipe at the most readable position.
- H. Install valve and snubber in piping for each pressure gauge for fluids (except steam).
- I. Install test plugs in piping tees in location that allows for ease of insertion of standard test kit probes.
- J. Install flow indicators in piping systems in accessible positions for easy viewing.
- K. Assemble and install connections, tubing, wiring, and accessories between flow-measuring elements, flowmeters and their controllers, and integrate with Energy Management and Control System as specified and as shown, all in accordance with manufacturer's written instructions.

3.3 LOCATIONS

- A. Install thermometers in the following locations, and as additionally shown on drawings:
 - 1. Inlet and outlet of each boiler, at boiler.
 - 2. Building supply heating water.
 - 3. Inlet and outlet of each air handler heating coil.
 - 4. Each main return branch in equipment room.
- B. Install pressure gauges in the following locations:
 - 1. One pressure gauge for each pump with 4 isolation ball valves and snubber, piped to read pressure before suction diffuser screen, at pump suction, at pump discharge, and atmospheric. Valve installed open to atmosphere for zero adjustment of each gauge.
 - 2. One pressure gauge for each differential pressure sensor with 3 isolation ball valves and snubber, piped to read pressure in either supply, return, or atmospheric. Valve installed open to atmosphere for zero adjustment of each gauge.
 - 3. One pressure gauge for each hydronic expansion tank with 2 isolation ball valves and snubber, piped to read pressure in tank air or atmosphere. Valve installed open to atmosphere for zero adjustment of each gauge.

4. One pressure gauge for each bypass filter with 3 isolation ball valves and snubber, piped to read pressure before and after filter or atmospheric. Valve installed open to atmosphere for zero adjustment of each gauge.
5. One pressure gauge for each boiler with 3 isolation ball valves and snubber, piped to read pressure before and after boiler or atmospheric. Valve installed open to atmosphere for zero adjustment of each gauge.

C. Test Plugs and Test Plug Kits:

1. Provide Pressure / Temperature Test Plugs at the supply and return connections to each new air / water heat transfer coil, adjacent to each thermometer and pressure gauge, and as noted on the drawings.

3.4 ADJUSTING

- A. After installation, calibrate meters and gauges according to manufacturer's written instructions. Coordinate calibration with Testing and Balancing Agency (TAB) and include results in TAB report.
- B. Adjust faces of meters and gauges to proper angle for best visibility.

3.5 THERMOMETER TYPE SCHEDULE

- A. Thermometers in interior locations that are temperature controlled to within the operating limits of the equipment shall be the following:
 1. Direct-mounted, light-activated type.
- B. Thermometers in exterior locations or interior locations designed to range outside of the normal operation conditions of light activated thermometers shall be the following:
 1. Industrial-style, liquid-in-glass type.

3.6 THERMOMETER SCALE-RANGE SCHEDULE

- A. Provide thermometers of approximately the scale range indicated:
 1. Scale Range for Heating, Hot-Water Piping: 30 to 250 deg F .

3.7 PRESSURE-GAUGE TYPE SCHEDULE

- A. Pressure gauges shall all be direct drive as specified.

3.8 PRESSURE-GAUGE SCALE-RANGE SCHEDULE

- A. Scale Range for Heating, Hot-Water Piping: 0 to 100 psi

END OF SECTION 23 05 19

SECTION 23 05 23 – GENERAL DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Brass and bronze ball valves.
 - 2. Iron, single-flange butterfly valves.
 - 3. Iron, grooved-end butterfly valves.
 - 4. Check Valves.
 - 5. Manual Balancing valves
 - 6. Automatic Flow Control Balancing valves.
 - 7. Pump Discharge Valves.
 - 8. Bronze globe valves.
 - 9. Air vent valves
 - 10. Chainwheels.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

1.4 SUBMITTALS

- A. Procedural Requirements: Comply with requirements of SECTION 01 33 00 - Submittals and as modified below.
 - 1. Specified Products: If product to be incorporated into Project is specified by name and product designation in Part 2 below, submit “**As-Specified Verification Form**” (attached to SECTION 01 33 00 - Submittals) in lieu of “Product Data” identified below in this Article.
 - 2. Equivalent Products or Substitutions: If product to be incorporated into Project is not specified by name and product designation in Part 2 below, comply with all Action Submittal requirements specified below.

B. Action Submittals:

1. Product Data: Submit concurrently for each type of valve proposed, demonstrating compliance with requirements.

C. Closeout Information, for inclusion in Operations and Maintenance Manual:

1. Approved submittal.
 - a. If “**As-Specified Verification Form**” submittal is approved, also include product data for all valves used.
2. Include all information required in SECTION 01 78 23 – Operation and Maintenance Data.
3. Receipt: For spare automatic flow control valve cartridges and Differential Pressure Flow Test Kit(s).
4. Valve Chart: Refer to Section 23 05 00 – Common Work Results for HVAC, for details.

1.5 QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 2. ASME B31.9 for building services piping valves.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

1.7 EXTRA MATERIALS

- A. Furnish extra materials that match products specified and that are packaged with protective covering for storage and identified with labels describing contents. Include receipt signed by Owner's representative in closeout documentation.
 - 1. Provide additional Automatic Flow Control Valve cartridges as specified below.
 - 2. Provide one complete Differential Pressure Flow Test Kit for each different type of balancing or flow control valve included in the project, with training as described below.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Refer to HVAC valve schedule articles for applications of valves.
- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- C. Valve Sizes: Same as upstream piping unless otherwise indicated.
- D. Valve Actuator Types:
 - 1. Gear Actuator: For quarter-turn valves NPS 6 and larger.
 - 2. Handwheel: For valves other than quarter-turn types.
 - 3. Handlever: For quarter-turn valves NPS 5 and smaller.
 - 4. Chainwheel: Device for attachment to valve handwheel, gear actuator stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.
- E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
 - 1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
 - 2. Butterfly Valves: With extended neck.
- F. Valve-End Connections:
 - 1. Flanged: With flanges according to ASME B16.1.
 - 2. Grooved: With grooves according to AWWA C606.
 - 3. Solder Joint: With sockets according to ASME B16.18.
 - 4. Threaded: With threads according to ASME B1.20.1.

2.2 BRONZE AND BRASS BALL VALVES

A. Two-Piece Ball Valves with Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Conbraco Industries, Inc.; Apollo Valves.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Two piece.
 - e. Body Material: Bronze.
 - f. Ends: Solder or Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Stainless steel.
 - i. Ball: Stainless steel, vented.
 - j. Port: Full or Regular per application schedule.

2.3 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Conbraco Industries, Inc.; Apollo Valves.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 150 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A 216 carbon steel, ASTM A 126, cast iron or ASTM A 536, ductile iron.
 - e. Seat: EPDM/Teflon, reinforced, resilient, for water temperatures up to 250 deg. F at 150 PSI.
 - f. Stem: 316 or 416 stainless steel shaft mounted within corrosion resistant bearings.
 - g. Disc: Aluminum bronze, bronze, or nickel coated iron.

2.4 IRON, GROOVED-END BUTTERFLY VALVES

A. 300 CWP, Iron, Grooved-End Butterfly Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Anvil International, Inc; “Gruvlock”.
 - b. NIBCO INC.
 - c. Victaulic Company.
2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. NPS 8 and Smaller CWP Rating: 300 psig.
 - c. Body Material: Coated, ductile iron.
 - d. Stem: Two-piece stainless steel.
 - e. Disc: EPDM/Teflon coated ductile iron.
 - f. Seat: EPDM/Teflon, reinforced, resilient, for water temperatures up to 250 deg. F at 150 PSI.

2.5 BRONZE GLOBE VALVES

A. Class 125, Bronze Globe Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Milwaukee Valve Company.
 - b. NIBCO INC.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded.
 - e. Stem and Disc: Bronze.
 - f. Packing: Asbestos free.
 - g. Handwheel: Malleable iron, bronze, or aluminum.

2.6 CHECK VALVES

- ### A. ½-inch to 2-inch Lines: Y-pattern swing-type manufactured in accordance with MSS-SP80, Class 125, bronze ASTM B-62 body with TFE seat disc; similar to “T413-Y (threaded) S413-Y (solder)” by Nibco.

- B. 2-1/2-Inch Lines And Larger: Swing-type manufactured in accordance with MSS-SP71, Class 125, flanged ASTM A126 Class B cast iron body with bronze trim, non-asbestos gasket; similar to “F918-B” by Nibco.
- C. Provide silent type where indicated and when check valves are installed in vertical lines.
 - 1. ½-Inch To 2-Inch Lines: Bronze body, ball-cone check, straight through design, ½ PSI opening pressure or other opening pressure if so indicated on drawings, bubble tight shut-off with liquid media, 125 PSIG steam rating; similar to “Apollo 61-100” by Conbraco.
 - 2. 2-1/2-Inch Line And Larger: Globe type, semi-steel body with bronze trim and stainless steel spring, 125 lb. ASA. Similar to “Fig. #105-MAP or #107-MAP” by Mueller Steam Specialty.

2.7 MANUAL BALANCING VALVES – USE ON SYSTEM 3 GPM OR LESS

- A. Provide combination globe-type calibrated flow measuring balance, shutoff, and throttling valve with provision for attaching portable differential pressure meter with each meter connection having positive shutoff access valves equipped with removable insulating cover providing minimum R of 4.5. Rated for 250 PSI at 250 deg. F and provided with calibrated nameplate, ¼-inch drain/purge port, and drip-tight shut off. Similar to “CBV” by Armstrong, “3D” by B & G, or similar products by Tour & Anderson.
- B. Threaded, grooved, or flanged ends as required to fit system piping with bronze, A-metal, or dezincification resistant brass body for pipe sizes ½-inch to 2-inches inclusive or cast or ductile iron body with bronze internal parts and Teflon or EPT seals rated for the service fluid and temperature for pipe size 2-1/2-inches and larger.
 - 1. Valves designed to allow for presetting of balance points for proportional system balance prior to system start up.
- C. Valve Size: As required to meet the Cv indicated on the Drawings, or if not indicated on Drawings, provide the larger of pipeline size or size required to provide maximum 5 ft. water gauge pressure drop at design flow.
- D. Read-Out Ports: Include internal EPT inserts and check valves.
- E. Adjustment Knob: Includes minimum of four full turns (1440 degrees) from bubble tight shutoff to full open position and includes pre-set feature indicating degree of valve opening including memory position stop and indicator.

2.8 AUTOMATIC BALANCING VALVES – USE ON SYSTEMS HIGHER THAN 3 GPM

- A. Provide each valve with an identification tag attached by chain, factory marked with the zone identification, valve number and flow rate. Valve to be line size.

- B. The GPM for the automatic flow control valves shall be factory set and shall automatically limit the rate of flow to within 5 percent of the specified GPM over at least 95 percent of the control range. Select and submit on automatic flow control valves based on flowrates shown on approved submittals.
- C. For ½ inch – 2 inch, the flow cartridge shall be removable from the Y- body housing without the use of special tools to provide access for regulator change-out, inspection and cleaning without breaking the main piping.
- D. Pump head requirement: The permanent pressure loss added to the pump head shall not exceed seven feet.
- E. Each valve shall have two P/T test plugs.
- F. Construction:
 - 1. For ½” through 2” pipe sizes: Assembly consisting of a de-zincification resistant (DZR) brass, bronze, or A-metal Y-type body, integral full port SS ball and stem ball valve and ‘O’ ring type union. For all insulated pipe services, provide manufacturer’s pre-formed insulation cover to fit each valve, with extended, insulated, non-condensing handle on ball valves.
 - 2. For 2 ½” and larger flanged connections: Ductile iron body suitable for mounting wafer style between standard 150# or 300# flanges. Provide long flange bolts and nuts with each valve.
 - 3. Stainless steel internal flow cartridge body and wear surfaces, with machined threads for spring free height adjustment, permanently marked with the GPM and spring range.
 - 4. Factory leak tested at 100 psi. air under water.
- G. Flow Verification:
 - 1. Differential pressure measured across the valve shall be measured for flow verification and to determine the amount of system over heading or under pumping.
- H. Design Make: IMI Flow Design Inc.

2.9 PUMP DISCHARGE VALVES

- A. Provide pump discharge valve for each new pump and as otherwise noted on drawings.
 - 1. For constant speed pump applications, provide pump manufacturer’s “triple duty valve” sized to provide maximum 3 feet water gauge pressure drop at the design flow.
 - 2. For variable speed pump applications, provide either pump manufacturer’s “triple duty valve” or a combination of a venturi measuring station, non-slam check valve, and isolation valve, all as specified. Size to larger of full line size or as required to provide maximum 3 feet water gauge pressure drop at the design flow.

B. Pump manufacturer's "triple-duty valve":

1. 175-psig pressure rating, cast-iron body of angle or straight pattern.
2. Globe style combination shutoff, calibrated multi-turn flow throttling / measuring, and spring loaded non-slam check valve.
3. Include gage ports with integral check valve, and provision for attaching a portable differential pressure meter, with each meter connection having positive shutoff access valves.
4. Provide with removable insulating cover providing minimum R value of 5.

C. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. "Model 3D Triple Duty Valve" by Bell & Gossett.
2. Armstrong.
3. Paco.
4. Victaulic.

2.10 AIR VENTS

A. Manual Air Vents:

1. For All Pipe Sizes In Accessible Locations Only: Bronze body, quarter turn ball valve with minimum 1/4-inch discharge and inlet connections. Provide collection chamber at inlet and 1/4-inch tube with return bend on outlet, piped to point of collection.
2. For Terminal Units In Accessible Locations: Bronze or brass body and non-ferrous internal parts, 150 PSIG working pressure, 225 deg. F operating temperature. 1/8-inch MNPT inlet connection. Coin or key operated, supply three keys minimum to owner. Similar to "Model 4V" by Bell & Gossett.

B. Automatic Air Vents:

1. High Capacity Type: Cast iron body with internal working parts of stainless steel, brass, bronze, and EPDM and float-operated sealing valve designed to purge free air from the system and provide positive shut off at pressures to 125 PSIG and temperatures to 250 deg. F. Vent prevents air from entering the system if system pressure drops below atmospheric. Vent readily serviceable by disassembly to access the internal working parts. Similar to "Model "107A" by Bell & Gossett or "720" by Amtrol.
2. Standard Capacity Type: Cast bronze body with internal working parts of stainless steel, brass, bronze and EPDM and float operated sealing valve designed to purge free air from the system and provide positive shut off at pressures to 150 PSIG and temperatures to 230 deg. F. Vent prevents air from entering the system if system pressure drops below atmospheric. Vent readily serviceable by disassembly to access the internal working parts. Similar to "No. 700-C" or "701-C" by Amtrol.

2.11 CHAINWHEELS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Babbitt Steam Specialty Co.
 - 2. Roto Hammer Industries.
 - 3. Trumbull Industries.
- B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
 - 1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
 - 2. Attachment: For connection to butterfly valve stems.
 - 3. Sprocket Rim with Chain Guides: Ductile or cast iron, of type and size required for valve. Include zinc coating.
 - 4. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

2.12 DIFFERENTIAL PRESSURE FLOW TEST KIT

- A. For each type of balancing valve and automatic flow control valve, include flow test kit with probes, hoses, flow charts, carrying case, and accessories as required for complete flow readings, and turn over to Owner. Obtain receipt.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage. Verify dielectric bolt kits are provided for flanged connections between dissimilar materials.
- E. Do not attempt to repair defective valves; replace with new valves.

3.2 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. Install special purpose hydronic valves (safety relief valves, reduced pressure zone backflow prevention devices, pressure reducing valves, etc.) as specified in section 23 21 13 – Hydronic Piping.

- B. Install isolation valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
 - 1. Install boiler isolation valves on system side of boiler specialty components especially safety components like relief valves and low water cutoff devices.
- C. Install isolation valves at each new branch connection serving three or more pieces of terminal equipment, and as additionally shown on drawings.
- D. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- E. If valves with specified CWP ratings are not available, the same types of valves with higher CWP ratings may be substituted.
- F. Select valves with the following end connections:
 - 1. For Copper Tubing, NPS 2 inch and Smaller: Threaded or solder joint ends.
 - 2. For Copper Tubing, NPS 2-1/2 inch and larger: Flanged ends.
 - 3. For Steel Piping, NPS 2 and Smaller: Threaded ends.
 - 4. For Steel Piping, NPS 2-1/2 inch and Larger: Flanged or grooved ends.

3.3 GENERAL DUTY VALVE SCHEDULE

- A. Unless otherwise specifically indicated elsewhere, use the following:
- B. Hydronic Flow Shutoff Service:
 - 1. 2 inch and smaller: Full Port Ball Valves
 - 2. 2-1/2 inch and larger: Butterfly Valves.
- C. Pressure Gage Shutoff Service: Standard or Full Port Ball valves.
- D. Flow Adjustment and Balancing:
 - 1. Provide line size manual adjustment balancing valves for service on branch main lines serving multiple terminal loads, where shown on drawings.
 - 2. Provide line size automatic flow control balancing valves for all individual terminal loads. Size valve flow cartridges based on approved equipment submittal flow rates where different from that scheduled. Include in contract changing cartridges on 10% of automatic flow control valves to some different flow as required during TAB and system commissioning work. Turn over original cartridges which have been changed, or the unused portion of the 10% extra, to the Owner with receipt.
 - 3. Select final flow based on approved submittals, not on flow indicated on contract documents.
 - 4. Train Owner's representative on balancing / flow control valve adjustment, use of differential pressure flow test kit, and also on changing automatic flow control valve cartridges.

E. Pump Service:

1. Suction: Provide full line size isolation valve at pump inlet before reducers, flex connections, and suction diffuser.
2. Discharge:
 - a. Constant speed pumps: Provide Pump Discharge Valves by pump manufacturer, full line size of system piping (typically larger than pump discharge size), after flex connections.
 - b. For VSD driven pumps, the pump discharge valve may consist of a manufacturer's triple duty valve or alternately a combination of a venturi measuring station as specified in Section 23 05 19, a non-slam check valve, and an isolation valve.
 - c. Install with sufficient length of straight pipe before and after valve as recommended by manufacturer to obtain good and stable measurements.

F. Hydronic System Drain Service: Provide drain valves at all system local or global low points as required for complete system drainage.

1. 2-1/2 inch and larger service: Provide 3/4 inch full port ball valves with 3/4 inch hose thread end and chained cap.
2. 2 inch and smaller service: Provide 3/4 inch full port ball or globe valves, with 3/4 inch hose thread end and chained cap.

G. Hydronic System Air Venting:

1. Manual vents: provide standard or full port ball valve, minimum 1/4" NPT; 1/2" NPT on 4" and larger piping.
2. Provide Standard Capacity Type Automatic Air Vent at accessible points in piping system where air may collect, including all local high points and at the end of each horizontal run before a drop in elevation.
 - a. If any such point will be inaccessible after construction is complete, provide only Manual Air Vent in lieu of automatic, installed as described below.
3. Equipment Air Vents:
 - a. Provide High Capacity Automatic Air Vent above each air and air/solids separator.
 - b. Boilers: Provide High Capacity Automatic Air Vent.
 - c. Equipment Above Mains: Connect run outs or risers to upper quadrant or top of mains. Install vent assembly at branch high point, concealed within enclosure if possible, consisting of 1 in. diameter by 6 in. long air collection chamber with 1/4 in. soft copper tube to manual valve. Mount securely near bottom of enclosure, but not fastened to enclosure. For individual units, radiators, fan convectors and units with return grilles: Provide coin air vent valve, operated from discharge grille or access door. Positioning of valve shall not interfere with removal of enclosure.

- d. Equipment Below Mains: Connect piping run outs or risers to bottom or lower quadrant of mains. Vent assembly not required in unit. Provide means of purging and draining each unit. Use tees instead of ells at low point of run outs.

3.4 VALVE INSTALLATION

- A. When installing solder-joint end valves, protect valve body from soldering heat using water soaked rags or other heat sink method as required to avoid valve damage. Leaking stems or seats on solder-joint end valves shall be subject to immediate replacement with new valve.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem and handle movement.
- E. Install all Automatic Air Vents above manual vent assembly described below, with discharge piped to point of collection - for glycol venting, pipe discharge to glycol feed station as shown, or if not shown to minimum 1 quart clear plastic container, secured and removable for service.
- F. Install all Manual Air Vents with air collection chamber above flow piping (minimum line size diameter x 6 inches long), and minimum 1/4" tube extended to accessible location, terminating with ball valve located so liquid discharged during venting may easily be collected in minimum 1 quart container.
 - 1. Coin vents may be connected directly to equipment served.
- G. Install chainwheels on operators for butterfly valves more than 96 inches above floor. Extend chains to no higher than 48 inches above finished floor, or longer as required to hang on adjacent wall hook out of the way.

3.5 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION 23 05 23

SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC COMPONENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.
- B. Division 06 section "Roofing Rough Carpentry" for roof mounted support blocking.

1.2 SUMMARY

A. Section Includes

- 1. Hangers and supports for (but not limited to) following components:
 - a. Piping hangers and supports
 - b. Duct hangers and supports
 - c. Equipment hangers and supports
- 2. Roof mounted supports and equipment penetrations including (but not limited to):
 - a. Roof curbs.
 - b. Combination equipment / pipe penetration curbs
 - c. Pipe curb assembly
 - d. Equipment support rails
 - e. Pipe and duct supports
- 3. Miscellaneous components and accessories including (but not limited to):
 - a. Anchors
 - b. Guides
 - c. Fasteners
 - d. Custom supports
 - e. Insulation protection systems

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of the Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

- A. This section does not detail mechanical vibration, movement, wind load, or seismic control requirements. Refer to Section 23 05 43 – MECHANICAL VIBRATION AND MOVEMENT CONTROL and Section 23 05 48 – MECHANICAL WIND LOAD CONTROL for additional hanger and support requirements.

- B. Provide corrosion resistant construction as described below for hangers, hanger rods, supports, fittings, hardware, etc, unless otherwise noted or approved. Note that not all products described below are available in corrosion resistance as required for all applications listed – select appropriate corrosion resistant products as required. Multiple conditions may apply, in which case the more corrosion resistant construction is required:
1. General purpose indoor: ASTM B-633 Fe/Zn 25 minimum zinc plated fasteners, ASTM B-653 G90 minimum sheet steel, factory baked enamel paint, or anodized.
 2. In contact with copper: Copper plated for size identification and felt lined or plastic coated.
 3. In contact with aluminum: Same aluminum alloy as equipment or 300 series stainless steel. 300 series stainless steel fasteners.
 4. Miscellaneous fabricated custom supports, anchor bases, etc.: painted in accordance with Section 23 05 00 – COMMON WORK RESULTS FOR HVAC.
 5. Other special conditions: where noted on drawings, provide materials of special temperature, corrosion resistance, or other properties, as required for durable and safe performance.
- C. Allowable Working Loads:
1. Use only manufacturer's load rated hangers, supports, and fasteners designed and rated for the intended service.
 2. Do not load connectors, hangers, or supports to more than the manufacturers' recommended working load or the following:
 - a. Use a safety factor of 5:1 minimum with respect to manufacturers' published ultimate shear strength.
 - b. Use a safety factor of 10:1 minimum with respect to manufacturers' published ultimate tension or pull-out strength.
- D. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, service loads, and test water.
 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
 3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.5 SUBMITTALS

- A. Product Data: Submit manufacturer's product literature, technical specifications, and other data required to demonstrate compliance with specified requirements for following components:

1. Hangers and supports
 2. Roof mounted supports
 3. Miscellaneous components
- B. Shop Drawings: Submit intended custom support construction for approval.
- C. All supports, etc., shall meet the approval of the Architects / Engineers. Submit shop drawings showing fabrication and installation details including calculations for the following; include Product Data for components:
1. Trapeze pipe hangers.
 2. Metal framing systems.
 3. Pipe stands.
 4. Equipment supports.
 5. Include detailed layout and loading drawings for all above roof piping and equipment.

1.6 QUALITY ASSURANCE

- A. Comply with applicable requirements of following standards for all hangers and supports:
1. MSS-SP-58 Pipe Hangers and Supports – Materials, Design, and Manufacture.
 2. MSS-SP-69 Pipe Hangers and Supports – Selection and Application.
 3. ANSI / ASME Code for Pressure Piping B 31.1
 4. ASTM standards for corrosion resistant Zinc coatings.
 5. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 6. UL 203 Standard for Pipe Hanger Equipment and Fire Protection Service
 7. Metal Framing Association MFMA-2
 8. ANSI/ NFPA NDS - National Design Specification for Wood Construction
 9. SMACNA – Sheet Metal and Air Conditioning Contractor's National Association, Inc.
- B. All welding shall be approved procedures performed by approved welders. Refer to Division 05 Section for "STRUCTURAL STEEL FRAMING", and Section 23 05 00 – COMMON WORK RESULTS FOR HVAC, for details on welder's qualification requirements.

PART 2 - PRODUCTS

2.1 GENERAL

- A. For convenience, details and specifications have been based on product types as defined in MSS SP-58 and 69 where applicable, and, where not applicable, catalog numbers shown have been based on products by the listed manufacturers.

2.2 PIPING ATTACHMENTS

A. Individually Suspended Horizontal Rigid Piping or Tube Attachments:

1. Band type:
 - a. 1-1/4 inch diameter pipe size and less only.
 - b. Formed steel loop overlapped at top with rod sized hole or insert nut. With or without side insert closure.
 - c. MSS SP-58 type 5, 6, or 10.
2. Clevis type:
 - a. Any size pipe or tubing.
 - b. Formed steel bands top and bottom connected by sheer bolt.
 - c. MSS SP-58 type 1.
3. Roller type:
 - a. Any size pipe or tubing.
 - b. Radiused or angled roller and steel axle; yoke for single hanger rod or end sockets for double rod applications. Designed to accommodate longitudinal movement through roller action.
 - c. MSS SP-58 type 41 and 43.
4. Provide products by one of the following manufacturers:
 - a. B-Line Systems, Inc., Highland Illinois, or equal
 - b. ERICO/Michigan Hanger Co.; Solon, Ohio, or equal
 - c. Grinnell Corporation; Pipe Support Division, Cranston, Rhode Island, or equal.

B. Supported from below Horizontal Rigid Piping or Tube Attachments:

1. Split Ring type:
 - a. 1-1/4 inch diameter pipe size and less only.
 - b. Cast malleable iron split ring with steel pivot and bolt, cast boss on one side threaded for standard rod or pipe attachment. Designed to accommodate minimal longitudinal movement only.
 - c. MSS SP-58 type 12.
2. Stanchion Saddle type:
 - a. Any size pipe and tubing.

- b. Radiused pipe saddle support with U-bolt upper restraint. Threaded adjuster rod or pipe integral / welded to saddle for vertical adjustment. Designed to accommodate minimal longitudinal movement only.
 - c. MSS SP-58 type 37.
 - 3. Roller type:
 - a. Any size pipe or tubing.
 - b. Radiused or angled roller and steel axle with end sockets for double rod applications. Provide with U-bolt upper restraint. Designed to accommodate longitudinal movement through roller action.
 - c. Roller MSS SP-58 type 41 and U-bolt MSS SP-58 type 24.
 - 4. Provide products by one of the following manufacturers:
 - a. B-Line Systems, Inc., Highland Illinois, or equal
 - b. ERICO/Michigan Hanger Co.; Solon, Ohio, or equal
 - c. Grinnell Corporation; Pipe Support Division, Cranston, Rhode Island, or equal.
- C. Group Supported or Suspended (Trapeze) Horizontal Rigid Piping or Tube Attachments (Common Support Beam):
- 1. Support frame or trapeze beam of load rated brackets or channel strut product.
 - 2. U-Bolt type:
 - a. Any size pipe or tubing.
 - b. Insulation support system rests directly on beam or shim, with U-bolt or split strut clamp upper restraint. Designed to accommodate minimal longitudinal movement only.
 - c. U-bolt MSS SP-58 type 24, Strut clamp similar to B-Line "B-2000" series.
 - 3. Radius Roller type:
 - a. Any size pipe or tubing.
 - b. Radiused roller and steel axle with end sockets for double rod applications. Provide with U-bolt upper restraint. Designed to accommodate longitudinal movement through roller action.
 - c. Roller MSS SP-58 type 41 and U-bolt MSS SP-58 type 24.
 - 4. Provide products by one of the following manufacturers:
 - a. B-Line Systems, Inc., Highland Illinois, or equal
 - b. ERICO/Michigan Hanger Co.; Solon, Ohio, or equal
 - c. Grinnell Corporation; Pipe Support Division, Cranston, Rhode Island, or equal.

D. Individual Vertical Rigid Piping and Tube Attachments:

1. Split Ring type:

- a. 1-1/4 inch diameter pipe size and less only.
- b. Cast malleable iron split ring with steel pivot and bolt, cast boss on one side threaded for standard rod or pipe attachment. Designed to accommodate minimal longitudinal movement only.
- c. MSS SP-58 type 12.

2. Riser clamp type:

- a. 1-1/2 inch diameter pipe size and larger.
- b. Twin formed steel bands with formed radius to fit pipe and extension wings drilled for clamping bolts, space between extension wings designed to accept various connections to building structure.
- c. MSS SP-58 type 8.

3. Provide products by one of the following manufacturers:

- a. B-Line Systems, Inc., Highland Illinois, or equal
- b. ERICO/Michigan Hanger Co.; Solon, Ohio, or equal
- c. Grinnell Corporation; Pipe Support Division, Cranston, Rhode Island, or equal.

E. Flexible Pipe, Tube, or Hose:

- 1. Lengths three feet and under to be supported by adjacent piping system.
- 2. Similar to attachments for rigid piping systems described above, with “V” notch bottom in lieu of radius, and associated continuous rigid trough angle of same material spanning between attachments.

F. Piping Insulation Protection Systems:

1. Pipe Insulation Shields:

- a. One Piece:
 - 1) Formed steel, minimum 8 gauge thickness, longer of 2 times diameter or 12-inch long minimum, and 180 degree circumference, sized for insulation thickness.
 - 2) MSS SP-58/69 type 40.
- b. Two Piece Sliding:
 - 1) Manufactured two piece sliding shield system designed to accommodate thermal movement.

- 2) MSS SP-58/69 type 40 inner shield similar to one piece shield above adhered to pipe insulation, with second outer shield of formed steel, minimum 18 gauge thickness, one times diameter length 6-inch long minimum, and 180 degree circumference, sized to fit outside inner shield, with formed ribs to keep shield centered on support clevis or trapeze.
 - 3) Inner and outer shields separated by layer of PTFE (Teflon), minimizing friction between shields and allowing minimum four inches controlled pipe movement relative to hanger without insulation damage or outer shield moving past the end of the inner shield.
2. Type "A" Insulation Protection System:
 - a. 1" piping and smaller only.
 - b. Provide one piece or two piece sliding shield as required by distance from piping anchors.
3. Type "B" Insulation Protection System:
 - a. 1¼" through 8" heating piping only.
 - b. Provide one piece or two piece sliding shield as required by distance from piping anchors.
 - c. Pipe Support Insulation: High density (20 pcf). molded fiberglass blocks consisting of fiberglass wool and urea-phenolic resin cured binder. Provide number and size of support blocks as required to limit deflection to 1% and avoid long-term damage to vapor barrier, and as required for pipe size and insulation thickness, in accordance with manufacturer's written guidelines and project details. Seal cut in piping insulation vapor barrier using manufacturer's recommended matching tape. Similar to AHAMFAB H-Block" by ICA
4. Type "C" Insulation Protection System:
 - a. Acceptable for any size heating or cooling piping.
 - b. Manufacturer's assembly consisting of insulation shield, high compressive strength insulation, and vapor barrier covering. May include hanger also.
 - c. Hanger: As required above, secured to shield and support insulation.
 - d. Insulation Shield: Provide one piece or two piece sliding shield as required by distance from piping anchors.
 - e. High Compressive Strength Insulation: 180 or 360-degree circumference insulation insert formed of water resistance treated hydrous calcium silicate (untreated cal-sil not acceptable) or cellular glass insulation, same thickness as adjacent insulation.

- f. Vapor Barrier Covering: White kraft outer surface bonded to aluminum foil, sandwiching reinforcing fiberglass skim yarn, permanently treated for fire and smoke safety and to prevent corrosion of the foil, with a vapor transmission perm rating of 0.02 or less. Seal to piping insulation vapor barrier using manufacturer's recommended matching tape.
 - g. Similar to Models "123", "124", "1031", and "4031" by ERICO/Michigan Hanger.
 - 5. Provide products by one of the following manufacturers:
 - a. B-Line Systems, Inc., Highland Illinois, or equal
 - b. ERICO/Michigan Hanger Co.; Solon, Ohio, or equal
 - c. ICA Inc.; Lehigh, Pennsylvania, or equal.
 - d. Buckaroos, Inc.
- G. Pipe Alignment Guides:
- 1. Steel Spider Clamp Type.
 - a. 2-1/2 inch diameter pipe size and larger.
 - b. Twin steel bands with formed radius to fit pipe, drilled for clamping bolts, welded extension "spider" wings sized to slide axially in matching welded and bolted outer housing ring with structural attachment legs.
 - c. Similar to "No. 650" and "No.651" by ERICO/Michigan Hanger
 - 2. Lightweight Steel Spider Clamp Type.
 - a. 2 inch diameter pipe size and smaller.
 - b. Three stamped steel bands with formed radius to fit pipe, drilled for clamping bolts, integral extension "spider" wings sized to slide axially in matching welded and bolted outer housing ring with structural attachment legs.
 - c. Similar to "Lite Weight Style V" by Metraflex
 - 3. Provide products by one of the following manufacturers:
 - a. B-Line Systems, Inc., Highland Illinois, or equal
 - b. ERICO/Michigan Hanger Co.; Solon, Ohio, or equal
 - c. Metraflex; Chicago, Illinois, or equal.
- H. Pipe Anchors:
- 1. Anchor Chair Type.
 - a. Steel Pipe 1/2 inch and larger.
 - b. Structural steel channel with V-notched flanges and U-bolt clamping device.
 - c. Similar to Figures "B3147A" and "B3147B" by B-Line Systems, Inc.

2. Anchor Clamp Type.
 - a. Steel Pipe 1/2 inch and larger.
 - b. Formed steel with radius to fit pipe, holes for clamping bolts, welded gusset reinforced as required, complete with matching base plate.
 - c. Similar to Figures "B3256" with "B3257" by B-Line Systems, Inc.
3. Riser clamp type.
 - a. Steel pipe and copper tube size 1-1/2 inch and larger.
 - b. Twin formed steel bands with formed radius to fit pipe and extension wings drilled for clamping bolts, space between extension wings designed to accept various connections to building structure.
 - c. MSS SP-58 type 8.
4. Provide products by one of the following manufacturers:
 - a. B-Line Systems, Inc., Highland Illinois, or equal
 - b. ERICO/Michigan Hanger Co.; Solon, Ohio, or equal
 - c. Metraflex; Chicago, Illinois, or equal.

2.3 DUCT ATTACHMENTS

- A. Per SMACNA Duct Manual standards for size, height, and location of ductwork, and as noted below.
 1. Materials and corrosion resistance as listed above.
 2. SMACNA load tables allow for no external loads on duct: provide for 200 lb external load on all duct hangers and supports. Increase hanger and support sizes from SMACNA tables accordingly:
 - a. Minimum band size 20ga. x 1 inch.
 3. Hanger bands to extend down sides and turn under bottom 1 inch minimum for all duct sizes. Minimum (2) #10 sheet metal screws per hanger (one each on side and bottom), (2) screws minimum on sides for duct over 12 inches tall, 12 inches on center max.
 4. Round exposed duct: hang from twin half round bands and rods, or as otherwise detailed.

2.4 BUILDING ATTACHMENTS

- A. Structural Steel Connectors:
 1. C-Clamp style:
 - a. FM approved, U.L. listed, steel or malleable iron C-clamp with hardened set screw and lock nut, tapped for rod size, typically eccentrically loads structure.

- b. Hanger rod bypasses structure: MSS SP-58 type 19.
 - c. Hanger rod in line with set screw: MSS SP-58 type 23.
 - 2. Center Loading Beam and Channel Clamp Style:
 - a. Forged or formed steel or malleable iron construction, beam clamps with connection for concentrically loading structure, of types as required by loading and configuration.
 - b. MSS SP-58 types 21, 27, 28, 29, and 30.
 - 3. Pivoting or Adjustable Connection Style:
 - a. Structural welding lug with forged steel clevis, side beam bracket, or other appropriate pivoting beam clamps as required for sloped steel.
 - b. Use for sloped steel, where thermal movement requires pivot, where seismic controls requires non-moment building connection, and elsewhere as required.
 - c. MSS SP-58 types, 21 or 22 with 16 or 17, 34, 57 with 14, etc...
 - 4. Provide products by one of the following manufacturers:
 - a. B-Line Systems, Inc., Highland Illinois, or equal
 - b. ERICO/Michigan Hanger Co.; Solon, Ohio, or equal
 - c. Grinnell Corporation; Pipe Support Division, Cranston, Rhode Island, or equal.
- B. Flanged Connectors:
- 1. Applicable for attachment to building steel, concrete, or wood.
 - 2. Malleable iron flange base, with central threaded hole for connection to threaded rod and symmetrical side hole for securing to structure with appropriate fasteners, typically used with split rings, similar to "Model No. 365M" by ERICO/Michigan Hanger.
 - 3. Pipe Stanchion Flanged Support Plate and Floor Stand: ASTM A-536 ductile iron support plate with 1-inch rolled thread adjustment stud and nut, or 1/4-inch carbon steel base plate welded to schedule 80 threaded steel pipe, designed for use with Stanchion Saddle style supports described above; similar to "PS1236 Redi-Jack Pipe Support" by Red Hed.
 - 4. Provide products by one of the following manufacturers:
 - a. B-Line Systems, Inc., Highland Illinois, or equal
 - b. ERICO/Michigan Hanger Co.; Solon, Ohio, or equal
 - c. Red Hed; Lincoln, Rhode Island. or equal.

2.5 ROOF MOUNTED SUPPORTS

- A. Roof Curbs: Double shell, galvanized steel, welded and painted, minimum thickness, with pressure treated wood blocking, braced and fully insulated with rigid fiberglass insulation (3 PCF). Includes gasket at top of curb for airtight seal between curb and ventilator or fan. Provide raised cant, recessed, or flanged curb bottom to suit roof construction and insulation , with custom profile to match sloped, metal or profiled roofing as required.

1. Steel Thickness: 20 gauge up to 36 inches, 18 gauge 38 to 72 inches, and 16 gauge over 72 inches. Provided with reinforcing and heavier gauge as required to adequately support weight load on curb; coordinate exact size with specified equipment.
 2. Minimum height of curbs above finished roof:
 - a. 12 inches for curbs supporting exhaust and relief air equipment.
 - b. 24 inches for curbs supporting outside air intakes.
 - c. For sloped roof curbs, curb of height sufficient to maintain bottom edge of supported equipment at above specified height.
 3. Provide with pressure treated blocking, through bolted to structure with stainless steel fasteners, as required bringing base of curb into proper plane for installation. Blocking minimum width to be no less than blocking height. Refer to Division 1 section "Roof Rough Carpentry" for additional details.
 4. Where required for specified vibration isolation system, provide curbs with integral restrained spring isolation system as described in more detail, refer to Section 23 05 43 - Mechanical Vibration and Movement Control and Section 23 05 48 – Mechanical Wind Load Control.
 5. Provide products by one of the following:
 - a. Pate or equal
 - b. Con-Fab or equal
 - c. Thy-Curb or equal
- B. Pipe Curb Assembly: Similar to Roof Curb specified above, equipped with fully welded curb cap top cover of heavy gauge aluminum (12ga), galvalume (16ga), or stainless steel (16ga) construction with integral curb counter flashing, raised flashing collars with replaceable neoprene pipe boot counter flashing secured with stainless steel clamps, size and number of pipe and conduit openings as required. Similar to Pate PCA curb with PCC-C custom curb cap package.
1. Provide products by one of the following:
 - a. Pate or equal
 - b. Con-Fab or equal
 - c. Thy-Curb or equal
- C. Combination Equipment / Pipe Penetration Curbs: Similar to Roof Curb combined with Pipe Curb Assembly, both as specified above, integrated with equipment platform. Includes solid pressure treated plywood equipment platform top with closed cell foam gaskets between platform and curb and 3-inch rigid fiberglass insulation below platform
1. Includes heavy gauge counter flashing, factory sealed to pipe penetration assembly with penetrations adequate for both mechanical and electrical system penetrations. Similar to "SCEB-5" by Pate.

2. Plywood deck minimum 1.5" thick. With steel rail reinforcing under as required for proper equipment securement. Secure deck to curb and stiffeners, with equipment secured through deck to stiffeners via captive SS nuts and bolts with exposed heads.
 3. Provide products by one of the following:
 - a. Pate or equal
 - b. Con-Fab or equal
 - c. Thy-Curb or equal
- D. Equipment Support Rails: Double shell galvanized steel, 14 gauge minimum, fully welded with solid bottom and ends. 2 inch x 8 inch treated wood top blocking, minimum 12 inches high above finished roof, minimum 2 inch turned out flange at bottom, C-channel top cap counter-flashing over blocking. Length to be the longer of 12 inches longer than equipment served or extended past equipment to next building structural support member, factory certified for weight of intended equipment at spacing of structure below, with reinforcement and heavier gauge as required. Units longer than eight feet may be field spliced with bolts and splice plates. Provide galvanizing paint at welds and field splices. Include top cap and integral base with raised cant where required. Provide raised cant, recessed cant, or flanged curb bottom to suit roof construction and insulation, with custom profile to match sloped, metal, or profiled roofing as required.
- E. Similar to custom "ES-5A" by Pate.
1. Provide products by one of the following:
 - a. Pate or equal
 - b. Con-Fab or equal
 - c. Thy-Curb or equal
- F. Non roofing penetration exterior duct supports:
1. Install per manufacturers recommendations, and as required to maintain roofing warranty. In general, assume installation on loose laid pad of PVC or EPDM reinforcement compatible with roofing, at least one half inch thick and 4 inches larger than support stand base. Provide base sizes load rated for distributing the supported weight at less than two pounds per square foot. Include snow load as shown on code compliance drawings. Provide detailed duct support layout drawings and support size / weight / roof loading calculations in submittal for all non roofing penetration exterior duct supports.
 2. Provide loose laid support stands with structural UV stabilized plastic (polypropylene, polycarbonate, FRP) or stainless steel deck base, with socket securing Hot Dipped galvanized or Stainless Steel channel duct support superstructure. Include mechanically bolted support angle clips, and cross member channels for both gravity support and uplift resistance. All fasteners to be stainless steel. Provide with radiused edges to protect roofing, drainage holes, and bolt down holes as required by seismic restraint system.
 3. Sliding clamped height adjustment supports, adjustable as required to achieve duct slope and roof clearance required.

4. Similar to “PPH-D Enclosed” by PHP. Provide products by one of the following:

- a. B-Line Systems, Inc., Highland Illinois, or equal
- b. RTS by Eberl Iron Works, Buffalo, NY, or equal
- c. Miro Industries, Inc., Murray, Utah, or equal
- d. Portable Pipe Hangers (PHP) Systems and Design, Houston, Texas, or equal

G. Non roofing penetration pipe supports:

- 1. Install per manufacturers recommendations, and as required to maintain roofing warranty. In general, assume installation on loose laid pad of PVC or EPDM reinforcement compatible with roofing, at least one half inch thick and 4 inches larger than support stand base. Provide base sizes load rated for distributing the supported weight at less than two pounds per square inch. Provide detailed piping support layout drawings and support size / weight / roof loading calculations in submittal for all non roofing penetration pipe supports.
- 2. 2 inch nominal and smaller pipe:
 - a. Loose laid pipe support stand with structural UV stabilized plastic (polypropylene, polycarbonate, FRP) deck base / roller housing, with load rated roller saddle running on nylon or SS bearing shaft. Provide with drainage holes, and bolt down holes as required by seismic restraint system.
 - b. Provide matching height adjustment spacers to achieve pipe slope required.
 - c. Manufacturer load rated as required.
 - d. Similar to “Pillow Block Pipestand Model 3-R” by Miro Industries, SS8-R by PHP.
- 3. 2½ inch to 6-inch nominal pipe:
 - a. Loose laid pipe support stand with structural UV stabilized plastic (polypropylene, polycarbonate, FRP) or stainless steel deck base and adjustment rod support, load rated roller saddle sized for pipe supported, and low friction corrosion resistant sleeve bearing inserts running on a stainless steel shaft. Provide with radiused edges to protect roofing, drainage holes, and bolt down holes as required by seismic restraint system.
 - b. Stainless steel threaded rod height adjustment roller supports, adjustable as required to achieve pipe slope and roof clearance required.
 - c. Where required height is larger than supported from below rollers allow, provide load rated channel frame and hanger system similar to PHP PSE-Custom.
 - d. Load rated as required for pipe supported.
 - e. Similar to “Pillow Block Pipestand” Models “X-RAHSS” by Miro Industries, PP10-xx by PHP.

4. Provide products by one of the following:
 - a. B-Line Systems, Inc., Highland Illinois, or equal
 - b. RTS by Eberl Iron Works, Buffalo, NY, or equal
 - c. Miro Industries, Inc., Murray, Utah, or equal
 - d. Portable Pipe Hangers (PHP) Systems and Design, Houston, Texas, or equal

H. Roofing Penetration Pipe and Duct Supports: Same construction as “Equipment Support Rails” specified above, minimum 12 inches high. Include full-length steel bracket, pipe rolls, adjustable upright supports, and accessories as required to secure piping or duct to support. Similar to “RAS” with “PRS-1 or 5” by Pate.

1. Provide products by one of the following:
 - a. Pate or equal
 - b. Con-Fab or equal
 - c. Thy-Curb or equal

2.6 MANUFACTURED METAL FRAMING SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Allied Tube & Conduit.
 2. Cooper B-Line, Inc.
 3. Flex-Strut Inc.
 4. Unistrut Corporation; Tyco International, Ltd.
- B. Description: Factory, shop, or field-fabricated support assembly made of steel channels, accessories, fittings, and other components, factory stock or custom designed and assembled for supporting diverse mechanical components.
- C. Standard: MFMA-4.
- D. Channels: Load rated continuous slotted steel channel with in-turned lips.
- E. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
- F. Corrosion resistance as described above.

2.7 EQUIPMENT SUPPORTS

- A. Provide custom designed hangers and supports to properly and resiliently support all contract equipment as required by special circumstances encountered. Suspend from above or support from below as shown on drawings and as required.
- B. Use structural carbon steel plate and shapes, secured by welding or bolts as required.

- C. Use load rated fasteners full size of the component attachment points unless specifically requested and approved otherwise.
- D. Provide lateral bracing as required minimizing potential for sway.
- E. Fabricate as required to transmit loads and reaction forces to structure, in accordance with applicable details and layouts shown on Drawings, and as approved by Architect. Submit load calculations and fabrication details for approval for all such supports including verified coordinated dimensions, weights, etc., of mechanical component, support component, and building structure proposed.

2.8 MISCELLANEOUS COMPONENTS AND ACCESSORIES

A. Piping Anchor and Guide Bases:

1. Provide custom designed piping anchor and guide bases as required to properly transmit the piping reaction forces to the building structure.
2. Triangulate fabrication to transmit reaction forces to deck edge of structure or other approved anchorage. Submit fabrication details for approval for all such supports including verified coordinated dimensions of support components and building structure proposed for attachment.
3. Use structural steel plate and shapes of pipe wall thickness minimum, with pipe diameter leg dimension minimum, secured by welding or multiple bolts of the pipe's hanger rod size minimum. Increase dimensions as required due to excessive unsupported length (greater than 15 pipe diameters) or moment bearing (bending) design.
4. Secure to at least two structural members, using at least three points of attachment designed to transmit both longitudinal and lateral piping reaction forces.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

C. Threaded Rods, Bolts, Nuts, Washers, Metals, Hardware, and Miscellaneous Assembly Components:

1. Provide manufacturer's load rated fasteners with size, strength and corrosion resistance as required for the application.
2. Rods, bolts, machine screws: rolled forged ANSI B1 Class 2A or better thread, bolts and screws with heads as required by the application, length as required for full thread engagement of but minimal projection past receiving connector including building attachment, (double) nuts, equipment attachment, etc.
3. Nuts: heavy pattern where space permits and where subject to repeated operation, ANSI B1 Class 2B or better thread.

4. Washers: US pattern where space permits, SAE pattern otherwise, with toothed or split lock washer when attached to equipment with moving or vibrating parts.
5. Sheet metal screws: self drilling, thread forming, hardened steel (hardened SS as required), load rated screws with hex heads designed for power driving
6. Structural Steel: ASTM A 36/A 36M, carbon-steel, black and galvanized, and/or series 300 Stainless Steel plates, bars, angles, channels, and other shapes in thickness and size as required for load.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Examine conditions under which hangers and supports are to be installed and notify Architect in writing of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in an acceptable manner.
 1. When Contractor confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to Architect written confirmation. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to Contractor.
 2. Identify any discrepancies between specifications and field conditions or changes required due to specific equipment selection, prior to installation. Corrective work required by discrepancies after installation at Contractor's expense.

3.2 GENERAL INSTALLATION

- A. Provide complete hanger and support systems for piping and ductwork systems and equipment, including all necessary attachments, fasteners, threaded rods, bolts, miscellaneous hardware, and associated work as required.
- B. Provide specified products, installed in accordance with applicable sections of this specification, in accordance with the manufacturer's recommended installation instructions, and as detailed on the Drawings.
- C. Support pipe, duct, and equipment from the building structure.
 1. Provide approved miscellaneous support structure as required to attach hangers and supports to building structure in conformance with all applicable standards and related specification sections.
 2. Do not use chain, perforated hanger strapping or band, wire hangers, or kinked, bent, or otherwise damaged hangers and supports.

3. Do not support one pipe from another, one duct from another, pipe from duct or equipment, or any similar combination.
 4. Install lateral bracing with pipe hangers and supports as required to prevent swaying.
 5. Provide special hangers and supports as shown on the drawings, as required to suit existing conditions, and as required for proper installation of equipment.
- D. Load Distribution: Install hangers and supports so that live and dead loads and stresses from movement will not be transmitted to connected equipment.

3.3 PIPE HANGER AND SUPPORT INSTALLATION

- A. Comply with MSS SP-58 and MSS SP-89 and as specified below. Install hangers, supports, clamps, and attachments as required properly supporting piping from the building structure.
- B. Trapeze Pipe-Hanger Installation: Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 2. Field fabricate from manufactured slotted channel system or structural shapes selected for loads being supported.
- C. Size piping attachments for insulated piping to fit outside insulation. Size piping attachments for un-insulated piping to fit outside diameter of pipe.
- D. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping. Provide for slope of trapeze supported piping systems with adjustable individual piping attachments.
- E. Accommodate thermal movement of piping systems.
 1. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
 2. Provide rods of sufficient length for ample swing. Hang rods from high points to allow maximum swing.
 3. Hang piping so that rods are vertical at the design temperature.
 4. Where length of rod and thermal expansion combine to cause more than 4 degrees angular movement of rod (or 1 inch lateral movement in a 12 inch rod), provide suitable linkage to permit swing and limit rods to tensile loading only, or, provide pipe roll.
 5. Where length of rod and thermal expansion would combine to cause more than 10 degrees angular movement of rod (or 2 inch lateral movement in a 12 inch rod), provide pipe roll.

6. More thermal movement is expected as the straight line distance from piping anchor points increases. Unless unusually long hanging rod length allows swing as indicated above, provide pipe roll hangers and supports at or above the following distances from piping anchor points indicated on drawing or installed in field. Deviations from below values subject to pre-approval:

<u>Piping Service</u>	<u>Distance from Anchorage</u>
a. Individual Copper Heating Service.	35 ft.
b. Trapeze Copper Heating Service.	20 ft
c. Individual Steel Heating Service.	60 ft.
d. Trapeze Steel Heating Service.	50 ft

F. Pipe Hangers and Supports Spacing (Maximum):

1. Provide hanger or support as close as possible to and within 24 inches of any elbow.
2. Provide hanger or support on branch pipe within 24 inches of main at takeoff / tee.
3. All Horizontal / Sloped Heating and Cooling Piping Systems:

<u>Piping Material</u>	<u>Maximum spacing of hangers</u>
a. Flexible piping or hose	Continuous
b. Copper ¾ in. and smaller	5 ft.
c. Copper 1 in. and 1-¼ in.	6 ft.
d. Copper 1½ in. and larger	8 ft.
e. Steel 1¼ in. and smaller.	7 ft
f. Steel 1½ in.	9 ft.
g. Steel 2 in. and larger	10 ft.
h. Annealed copper	3 ft.

4. Vertical Piping:

a. Steel and Copper 1¼ in and smaller	Two per floor level.
b. Steel and Copper 1½ in and larger	One per floor level.

G. Insulated Piping

1. Center insulation shields at piping attachments and secure shield from lateral movements by wrapping PVC tape around circumference of piping insulation and shield at both ends of shield.
2. At all piping attachments, provide piping insulation protection system of strength and configuration required to guarantee integrity of pipe insulation and associated vapor barrier. Refer also to SECTION 23 07 00 INSULATION.

3.4 BUILDING ATTACHEMENTS INSTALLATION

A. Threaded Rod for Hangers:

1. Double nut each end of each rod. Threaded clamp, turnbuckle, etc. counts as one nut.

2. Rod size for individual pipe hangers and two rod / two pipe or duct trapeze style supports:

<u>Rod size:</u>	<u>for Pipe size:</u>	<u>for Duct size:</u>
3/8"	2" and smaller.	48" wide to 72"
1/2"	2-1/2" and 3".	
5/8"	4" and 5".	

3. For multiple pipe or duct trapeze style supports with two rods for more than two pipes or two or more ducts, size rods according to manufacturers recommended safe working loads taking into account total hung weight, 200 pound live load, as well as capacity of structure; each rod not smaller than size shown above for largest pipe or the sum of the duct width in the trapeze. Submit details of all such supports and connectors for approval before construction, including schedule of proposed sizes and capacities.

- B. Fastener Systems: Provide screws, bolts, approved anchors, etc., to secure piping, duct, equipment, supports, and miscellaneous components and accessories to structure. Nailing not permitted.

1. Install all fastener systems and anchorage in strict accordance with fastener manufacturer's instructions and as otherwise indicated below.
2. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 3" and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
3. Minimize eccentric loading of structure as follows:
 - a. For paired point loads eccentrically suspended (C-clamp attached supply and return pipes, etc), suspend from opposite edges of structural member.
 - b. For point loads over 400 pounds, use center loading beam clamps or other structurally concentric building attachment, and confirm proposed configuration with Engineer by submittal.

3.5 DUCT HANGERS AND SUPPORTS

- A. Install per SMACNA duct manual and as modified by the requirements of this section.
- B. Provide support spacing per building structural system but not greater than 8 feet. Provide extra support structure as required.

3.6 ELECTRICAL WORK HANGER AND SUPPORT INSTALLATION

- A. Refer to Division 26 complete.

3.7 ROOFTOP SUPPORT INSTALLATION

A. Rooftop Supports for Piping, Duct, and Service Access:

1. Non-roofing penetration supports:
 - a. Install per manufacturers recommendations, and as required to maintain roofing warranty. In general, assume that cleaning area of roofing at each support is required with installation on loose laid pad of PVC or EPDM reinforcement compatible with roofing, at least one half inch thick and minimum 4 inches larger than support stand base.
 - b. Attach supports to roof as required for wind, and thermal movement control with compatible rooftop fasteners through holes drilled in bottom of pipe stand pitch pan at time of installation. Fill pitch pan with asphalt material or cement as directed to seal areas around fasteners watertight.
 - c. Center supports beneath duct or pipe so cradle allows pipe to be squarely over and through cradle pipe stand. Align platform supports adjacent to equipment requiring service access as required provided optimized access.
 - d. Adjust to desired height insuring level platforms, level horizontal bars, proper longitudinal pitch for pipe and duct, and even load distribution among all supports.
 - e. Set equipment in support without dropping or causing undue impact. Assemble platform grating and secure to superstructure.
 - f. Assemble duct and piping restraints and handrails, and make final adjustments to alignment and level.
2. Curb-Mounted-Type Pipe and Duct Supports: Assemble components and mount on permanent, stationary roof equipment support rails or curb. Equipment Support Rails

B. Roof Curbs, Pipe Curbs, and Equipment Support Rails:

1. Provide larger of curb height scheduled on Drawings or as recommended by equipment manufacturer, but not less than 12 in. above finished roof. Refer to required installation details and provide additional curb height where finished roof surface is above curb mounting flange.
2. Provide all roof curbs required for all rooftop-mounted equipment in Contract.
 - a. Provide structural support for roof deck around all roof curbs and roof deck penetrations 12 inch x 12 inch and larger, unless specifically indicated otherwise elsewhere on the Contract Documents. Align support frame with inner edge of curb. Refer to drawings for additional support details around roof openings.
 - b. Bolt curbs through blocking to structure with stainless steel fasteners, as required for seismic and wind movement control.

- c. Refer to Section 06 10 26 – ROOFING ROUGH CARPENTRY, for additional wood blocking requirements.
- d. Verify exact size and location and set and secure unit to roof.
- e. Set and secure curb or support level as required by manufacturer of equipment served and as required by the installation details of the seismic restraint system. Provide tapered shims as required up to 3-1/2 inch thick. If structure slopes more than 3-1/2 inch over length of curb, provide sloped curb to match structure so as to minimize shims. Provide corrosion-resistant fasteners as required to secure curbs to deck or structure, coordinate with subsequent roofing requirements.
- f. Coordinate roof openings and set and secure curbs in ample time so as to avoid delay in construction schedule.
- g. Coordinate in curb access and rooftop equipment sound transmission mitigation:
 - 1) Coordinate roof deck removal within curbs in all cases with Architect, Owner, Construction Manager and all affected trades as required to optimize access and sound transmission prevention.
 - 2) In general, for exhaust fan, roof top hood, pipe, and combination equipment / pipe penetration curbs, provide for below curb service access by complete removal of roof deck internal to curb throat free area.
 - 3) In general, for Roof Top Air Handling Units, provide in curb sound attenuation and acoustically rated roof deck penetrations as specified in Section 23 05 43 – MECHANICAL VIBRATION AND MOVEMENT CONTROL.
 - 4) Coordinate special circumstances requiring exceptions to above with Architect and equipment manufacturers.
- h. Prevent water entry into building. Provide roofing work as required to flash curbs. Provide counter flashing and gaskets with curb mounted equipment as required to keep water from entering curb. Provide temporary caps as required until permanent installation is made.

3.8 METAL FRAMING AND EQUIPMENT SUPPORT INSTALLATION

- A. Provide miscellaneous metal, beams, angles pipe bars, structural steel shapes, bases, braces, etc. accessories required to attach hangers and supports to walls, floors, structural members, etc. in conformance with Section 05 12 00 – “STRUCTURAL STEEL FRAMING”.
- B. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- C. Custom Hangers and Supports: Install as required by special circumstances encountered, in accordance with applicable details and layouts shown on Drawings, and as approved by Architect.

- D. Provide lateral bracing to prevent swaying for equipment supports.
- E. Provide vibration isolation, seismic restraint, and thermal movement capability for hangers and supports. Refer to Section 23 05 43 - MECHANICAL VIBRATION AND MOVEMENT CONTROL and Section 23 05 48 – MECHANICAL WIND LOAD CONTROL.
- F. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- G. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- H. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.9 ADJUSTING

- A. Adjust all hangers and supports after installation of piping and associated equipment to distribute loads equally on attachments and to achieve proper pitch for the applicable piping system.
- B. Trim excess length of continuous-thread hanger and support rods as required - avoid hazardous protrusion.

3.10 PAINTING AND TOUCHUP

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 23 05 29

SECTION 23 05 43 – MECHANICAL VIBRATION AND MOVEMENT CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes mechanical movement controls for all mechanical equipment and components, piping, and duct work provided or modified as a part of this Project and as noted on the drawings, whether movement is from sound, vibration, thermal, or other sources including (but not limited to):
 - 1. Vibration isolation hangers and mounts for equipment, piping, and ductwork.
 - 2. Equipment isolation bases.
 - 3. Flexible piping and flexible piping connections.
 - 4. Resilient anchors and guides.
 - 5. Duct sound attenuation.

1.3 CONTROL AND RESOLUTION OF WIND LOAD FORCES

- A. This section does not include control and resolution of seismic or wind load forces acting on mechanical systems. Refer to Section 23 05 48 – Mechanical Wind Load Control for additional information.

1.4 DEFINITIONS

- A. IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.

1.5 PERFORMANCE REQUIREMENTS

- A. Provide mechanical sound, vibration, and movement control for all mechanical equipment, piping, duct work, and other components provided or modified as a part of this Project, and as shown on the Drawings. Mount on or suspend from vibration isolators to reduce transmission of vibration and mechanically transmitted sound to building structure. Select vibration isolators in accordance with weight distribution to produce reasonably uniform deflections.
 - 1. Correct any variance or non-compliance with specified requirements in manner directed by Architect.

1.6 SUBMITTALS

- A. General: Submit all action submittals and informational submittals required by this Section concurrently.
- B. Action Submittals:
 - 1. Product Data for the following:
 - a. Catalog cuts and data sheets on vibration isolators, isolation bases, and isolation curbs. Indicate rated load, rated deflection, and overload capacity for each device. Annotate to indicate application of each product submitted and compliance with requirements.
 - b. Catalog cuts and data sheets on sound attenuation components used. Indicate style, material, and attenuation characteristics for each device or product.
 - c. Schedule of flexibly mounted equipment, referencing drawings by number. Include number, type, and loading of all isolation components.
 - 2. Shop Drawings
 - a. Submit details of following items
 - 1) Equipment bases including dimensions, structural member sizes and support point locations. Equipment bases shall include all curbs for rooftop air handling units.
 - 2) Isolation hangers and systems for ceiling hung equipment, piping and ductwork.
 - 3) Mountings for floor supported equipment, piping and ductwork.
 - 4) Complete flexible connector details.
 - b. Indicate deflections and model numbers on all hanger, mounting or pad drawings including any other specified requirements.
 - c. Provide in tabular form spring diameters, rated loads and deflections, heights at rated load and closed height for all springs shown in submittals.
- C. Informational Submittals:
 - 1. Product Certificates:
 - a. Contractor Statement of Responsibility: Refer to Division 01 Section, "Quality Requirements".
 - 2. Welding certificates.

D. Closeout Submittals:

1. Field quality-control test reports.
2. Contract Closeout Submittals: Comply with requirements of Section 01 73 00, including submission of operating and maintenance instructions as item in "General Construction Instructions" manual described in that section.

1.7 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.8 COORDINATION

- A. Coordinate layout and installation of vibration isolation and movement control devices with other construction that penetrates ceilings or is supported by, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
- B. Coordinate size and location of concrete housekeeping pads and vibration isolation bases. Cast anchor-bolt inserts into base. Refer to applicable technical sections in Division 03 for concrete, reinforcement, and formwork requirements.
- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.
- D. Coordinate design of vibration isolation design with expansion compensation systems.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Amber/Booth Company, Inc.
 2. Kinetics Noise Control.
 3. Mason Industries.
- B. Factory Finishes: Provide manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
1. Powder coating on springs and housings.
 2. All hardware shall be galvanized. Hot-dip galvanized metal components for exterior use.
 3. Baked enamel or powder coat for metal components on isolators for interior use.
 4. Color-code or otherwise mark vibration isolation devices to indicate capacity range.

- C. Where neoprene is referred to and used in vibration isolation components, it shall be bridge-bearing grade premium neoprene of the durometer hardness grade and size specifically recommended by the design make manufacturer for both maximum vibration isolation and load rated for the specific application.
- D. Isolation Mountings
1. Neoprene Mountings: Provide minimum static deflection of 0.35-inch with all metal surfaces neoprene-covered and having friction pads both top and bottom.
 - a. Bolt holes provided on base, isolated from tapped bolt hole with cap screw on top.
 - b. Steel frame bases used above mountings to compensate for overhang.
 - c. Basis-of-Design Product: Mason Industries, Inc.; Type ND or Rails Type DNR.
 2. Restrained Neoprene Mountings: OSHPD pre-approved vibration isolation mounts with captive opposed neoprene inserts, minimum static deflection of 0.2-inch.
 - a. Restraint rated at 2G minimum in all directions.
 - b. Plated steel frame with base mounting holes, isolated from tapped bolt hole with cap screw on top.
 - c. Basis-of-Design Product: Mason Industries, Inc.; Type BR.
 3. Spring Isolators: Freestanding and laterally stable without housing and complete with molded neoprene cup or 1/4-inch neoprene acoustical friction pad between base plate and support.
 - a. All mountings with leveling bolts rigidly bolted to equipment.
 - b. Installed heights and operating heights equal.
 - c. Ratio of spring diameter divided by compressed spring height no less than 0.8.
 - d. Springs have minimum additional travel to solid equal to 50 percent of rated deflection.
 - e. Include spring diameters, deflection, compressed spring height and solid spring height in Submittals specified in Part 1 above.
 - f. Basis-of-Design Product: Mason Industries, Inc.; Type SLF.
 4. Restrained Spring Mountings: Spring Isolator as above, within rigid housing including vertical limit stops to prevent spring extension when weight is removed.
 - a. Housing serves as blocking during erection. Steel spacer removed after adjustment. Installed and operating heights equal.
 - b. Minimum clearance of 1/2-inch maintained around restraining bolts and between housing and spring to avoid interfering with spring action.
 - c. Limit stops out of contact during normal operation.
 - d. Provide internal isolation pad since housings bolted or welded in position.
 - e. Basis-of-Design Product: Mason Industries, Inc.; Type SLR.

E. Hangers

1. Neoprene Hangers: Rigid steel frames containing neoprene element.
 - a. Minimum 1-1/4-inch thick neoprene element on bottom with projecting bushing preventing steel-to-steel contact.
 - b. Minimum static deflection of 0.20-inch.
 - c. Boxes not articulated, clearance hole in neoprene element to allow non-moment bearing connection at structural support.
 - d. Configured for threaded rod, eye bolt, or strap connections as required.
 - e. Basis-of-Design Product: Mason Industries, Inc.; Type HD.
2. Type A Hangers: Rigid steel frames containing minimum 1-1/4-inch thick neoprene elements at top and steel spring with general characteristics as specified for Spring Isolator above seated in steel washer reinforced neoprene cup on bottom.
 - a. Neoprene element and cup have neoprene bushings projecting through steel box.
 - b. Boxes not articulated as clevis hangers nor neoprene element stacked on top of spring in order to maintain stability.
 - c. Spring diameters and hanger box lower hole sizes large enough to permit hanger rod to swing through 30-degree arc from side-to-side before contacting cup bushing and short-circuiting spring.
 - d. Include hanger drawing showing 30-degree capability.
 - e. Basis-of-Design Product: Mason Industries, Inc.; Type 30N.
3. Type B Hangers: Similar to Type A Hangers specified above with following modifications.
 - a. Pre-compressed and locked at rated deflection by means of resilient up-stop to keep piping or equipment at fixed elevation during installation.
 - b. Designed with release mechanism to free spring after installation is complete and hanger subjected to full load.
 - c. Deflection clearly indicated by means of scale.
 - d. Include drawing of hanger showing 30-degree capability in Submittals required in Part 1 above.
 - e. Basis-of-Design Product: Mason Industries, Inc.; Type PC30N.
4. Vibration Hangers: Similar to Type A Hangers specified above with following modifications.
 - a. Provided with weldless eyebolts top and bottom to facilitate attachment to flat duct straps.
 - b. Basis-of-Design Product: Mason Industries, Inc.; Type W30N.

F. Vibration Isolation Bases:

1. Structural steel bases: Welded structural steel shapes sized to fit equipment furnished by vibration isolation component manufacturer. Rectangular bases preferred for all equipment.
 - a. Centrifugal refrigeration machines and pump bases either "T" or "L" shaped where space is limited.
 - b. Pump bases for split case pumps provided large enough to support suction and discharge elbows.
 - c. Steel beams provided as all perimeter members with minimum depth equal to 1/10 of longest dimension of base.
 - d. Maximum 14 inches base depth; keep deflection and misalignment within acceptable limits as determined by manufacturer.
 - e. Height saving brackets employed in all mounting locations to provide base clearance of 1-inch.
 - f. Mount vibration isolation bases on restrained spring mounts.
 - g. Basis-of-Design Product: Mason Industries, Inc.; Type WF.
2. Inverted Saddles: Steel members provided by vibration isolation manufacturer and welded to height-saving brackets to cradle equipment having legs or bases not requiring complete supplementary base.
 - a. Includes sufficiently rigid members to prevent misalignment of equipment.
 - b. Mount inverted saddles on restrained spring mounts.
 - c. Basis-of-Design Product: Mason Industries, Inc.; Type ICS.

G. Piping Vibration Isolation and Movement Control

1. Expansion Joints: Flexible spherical expansion joints with peroxide-cured EPDM in covers, tubes and fractioning for Kevlar reinforcement, and solid steel rings in raised face rubber ends to prevent pull-out used in piping at connections to vibration-isolated equipment, rated for a minimum of 1/2-inch compression and elongation, 1-inch lateral, and 10-degree angular misalignment. Solid steel rings used within raised face rubber ends to prevent pullout. Flexible cable bead wire not acceptable.
 - a. Sizes
 - 1) 2-Inch and Larger: 2 spheres reinforced with ring between spheres to maintain shape and complete with split ductile iron or steel flanges with hooked or similar interlocks.
 - 2) 3/4-Inch to 1-1/2-Inch: Threaded bolted flange assemblies acceptable, 1 sphere and cable retention.
 - b. Connectors: Rated at 250 psi up to 190 deg F with uniform drop in allowable pressure to 190 psi at 250 deg F., providing minimum of 3/1 safety factors to burst and flange pullout, and with all joints permanently marked verifying 5-minute factory test at twice rated pressure.

- 1) Concentric reducers complying with requirements for “Connectors” acceptable in lieu of equal ended expansion joints.
 - c. High-Pressure Joints: Acceptable in lieu of expansion joints where operating pressures higher than standard.
 - d. Install expansion joints in piping gaps equal to length of expansion joints under pressure.
 - e. Control rods used only in unanchored piping locations where manufacturer determines installation exceeds pressure requirement without control rods. If control rods are used, include 1/2-inch thick neoprene washer bushings large enough in area to take thrust at 1000 psi maximum on washer area.
 - f. Install expansion joints on equipment side of shut-off valves.
 - g. Test Reports: Include 2 test reports by independent consultants showing minimum reductions of 20 dB in vibration accelerations and 10 dB in sound pressure levels at typical blade passage frequencies on specified product or similar product by same manufacturer.
 - h. Basis-of-Design Product: Mason Industries, Inc.; Safeflex SFDEJ, SFEJ, SFDCR or SFU and Control Rods CR.
2. Flexible Equipment Piping Connectors: Connections rated for a minimum of 1/8-inch compression and elongation, 1/2-inch lateral, and 5-degree angular misalignment. Provide connectors with flanged, grooved, or threaded end connections meeting specified requirements for fittings and sized to match equipment connected with integral, tapered, concentric size reductions where equipment and piping are not the same size.
- a. Provide one of the following flexible connector types:
 - 1) Flex Hose Type: Stainless steel annular corrugated closed pitch bellows with braided stainless steel wire reinforcing protective jacket, internally and externally continuously TIG welded to end fittings. Minimum 150 psig working pressure at 250 degrees F operating temperature.
 - a) Design Make: “SECF” by Southeastern Hose or similar product by Flex-Hose.
 - 2) Spherical Reinforced Elastomeric Type: minimum pressure range of 16 in Hg. vacuum to 150 psig over full temperature range of -20 deg. F to +240 deg. F. Connectors have metal flanged ends tapped to mate with standard 150# or 300# companion flanges, elastomer compatible with the working fluid, and high strength low stretch polymeric reinforcement. Provide complete with pipe anchors or control units as required for system pressure control.
 - a) Design Make: “Safeflex” by Mason or “Flexzorber” by Flex-Hose.

- 3) Flexible Mechanical Connector Type: three minimum flexible mechanical grooved couplings, as specified in Section 23 21 13 – HYDRONIC PIPING, installed adjacent to equipment and before first hanger. May be arranged between tapered increasers, check valves, flow measuring stations, etc., or separated by short pipe nipples.
 - a) Design Make: Style 77 flexible couplings by Victaulic.
3. Flexible Hose: Factory assembled lengths sufficient to handle the anticipated flexing required due to either installation or thermal movement and rated for minimum 150 psig working pressure at 210 deg F operating temperature.
 - a. Provide one of following two styles of flexible hose. Pipe size listed on Drawings are for smooth bore hose; provide corrugated style hose one pipe size larger:
 - 1) Stainless steel or bronze annular or helically corrugated closed pitch bellows with braided stainless steel or bronze wire reinforcing protective jacket, continuously TIG welded or silbrazed to end fittings.
 - a) Basis-of-Design Product: Flex-Hose Co., Inc.; Corrugated Metal Hose.
 - 2) Smooth bore polymer liner with braided stainless steel or bronze wire reinforcing protective jacket, mechanically swaged to the end fittings.
 - a) Basis-of-Design Product: Flex-Hose Co., Inc.; Polyflex.
 - b. Provide connectors with flanged, grooved, or threaded end connections meeting requirements specified for fittings and including external pipe thread one end and internal pipe thread adapter swivel or union other end for sizes through 2-inch, with flanges on both ends for sizes over 2-inch.
 - c. Rated for static and intermittent flexing radii no greater than that of the design make (approximately 3 diameters static and 8 diameters dynamic).
 - d. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Flex-Hose Co., Inc.; Corrugated Metal Hose or Polyflex.
 - 2) Mason Industries, Inc.; Type BSS or BFF.
 - 3) Southeastern Hose, Inc.; SECM or SECC.
4. Piping Expansion Loops: Provide minimum rated movement of +/- 1.5 inches from neutral position unless specified otherwise on drawings.
 - a. Assembly imparts less than 50 pounds per inch of pipe diameter (example: 4-inch pipe x 50lb./in. = 200lb. maximum) axial thrust on pipe system at design working pressure at full extension or compression. Document axial thrust loads on submittal.
 - b. Provide threaded drain/vent on the return bend for loops installed at other than slope of adjacent piping.

- c. Provide nested loop configuration where required by space restrictions.
 - d. Steel pipe flexible loops flanged, groove jointed, or provided with threaded ends connected to unions depending on size and application. Flexible loops installed in copper tube runs have threaded ends connected to unions. Welded or soldered ends not acceptable.
 - e. Bellows type not permitted. Welded hard loops only permitted as delegated design with loop width, length, and associated thrust anchor calculations performed and stamped by contractor's qualified licensed engineer.
 - f. Provide one of the following expansion loop types:
 - 1) Factory-manufactured U or V shaped pipeline flexible loop expansion compensators consisting of rigid pipe bends connected by two or three lengths of flexible braid reinforced hose. Provide U bend configuration with minimum 360 degree total bend unless shown as V configuration on drawings.
 - a) Flexible braid reinforced hose and fittings as specified above.
 - b) Provide manufacturer's breakaway hanger for return bend as required to allow full range of motion
 - c) Design Makes: "Metraloops" by Metraflex, "Tri-Flex Loop" by Flexhose;
 - 2) Field fabricated flexible mechanical coupling U bend system.
 - a) System to consist of four 90 degree elbows installed with eight flexible mechanical grooved couplings with two lateral and one run pipe stubs in line between the elbows, assembled into a U bend configuration.
 - b) Coupling manufacturer to provide calculations for lateral and run pipe length requirements required to achieve specified movement and end thrust limits.
 - c) Design Make: Elbows and Style 77 flexible couplings by Victaulic.
5. Split Wall Seals: 2 bolted pipe halves with minimum 3/4-inch thick neoprene sponge centered to inner faces with seal tightened around pipe to eliminate clearance between inner sponge face and piping and installed to project minimum of 1-inch past either face of wall.
- a. Concrete may be packed around seal to make it integral with floor, wall or ceiling if seal is not already in place around pipe prior to construction of building member.
 - b. Where temperatures exceed 240 deg F, 10# density fiberglass may be used in lieu of sponge.
 - c. Basis-of-Design Product: Mason Industries, Inc.; Type SWS.

6. All-Directional Acoustical Pipe Anchor: 2 sizes of steel tubing separated by minimum 1/2-inch thick 60 durometer neoprene with vertical restraint provided by similar material arranged to prevent vertical travel in either direction and with allowable loads on isolation material not exceeding 500 psi and design balanced for equal resistance in any direction.
 - a. Basis-of-Design Product: Mason Industries, Inc.; Type ADA.
7. Pipe Guides: Telescopic arrangement of 2 sizes of steel tubing separated by minimum 1/2-inch thickness of 60 durometer neoprene with height preset with shear pins to allow vertical motion due to pipe expansion or contraction.
 - a. Shear pin removable and capable of re-insertion to allow for selection of pipe movement.
 - b. Guides capable of +/-1-5/8 inches (40mm) motion, or to meet location requirements.
 - c. Basis-of-Design Product: Mason Industries, Inc.; Type VSG.
- H. Curb Mounted Rooftop Equipment: Mounted on spring isolation curbs with sheet metal "Z" section lower member supporting upper floating section and upper frame providing continuous support for equipment and captive to resiliently resist wind forces.
 1. All directional neoprene snubber bushings minimum of 1/4-inch thick.
 2. Steel springs laterally stable and resting on 1/4-inch thick neoprene acoustical pads.
 3. Hardware plated and springs provided with rust-resistant finish.
 4. Curbs waterproofing consists of continuous galvanized flexible counter flashing nailed over lower curbs waterproofing and joined at corners by EPDM bellows.
 5. All spring locations have access ports with removable waterproof covers.
 6. Lower curbs have provision for 2 inches of insulation.
 7. Curbs have OSHPD anchorage pre-approval "R" number certifying seismic capability.
 8. Basis-of-Design Product: Mason Industries, Inc.; Type RSC.
- I. Horizontal Thrust Restraints: Spring element in series with neoprene-molded cup as specified above for "Spring Isolators" with same deflection as specified for mountings or hangers supporting unit and designed to be preset for thrust at factory and adjusted in field to allow for maximum of 1/4-inch movement at start and stop.
 1. Assembly furnished with rod and angle brackets for attachment to both equipment and ductwork or equipment and structure.
 2. Horizontal restraints attached at centerline of thrust and symmetrical on either side of unit.
 3. Basis-of-Design Product: Mason Industries, Inc.; Type WBI/WBD.

2.2 ACOUSTICAL ATTENUATION COMPONENTS

- A. Submit published sound attenuation data for all sound attenuation components generated by a certified aero-acoustical testing laboratory in full accordance with ASTM E 477, Standard Method of Testing Duct Silencers. Provide all attenuation components complying with NFPA 90-A requirements.

- B. Duct / Pipe Lagging: 2mm thick barium sulphate-loaded vinyl sheet bonded to fiber scrim reinforced aluminum coating on outer side and to 1-inch thick mineral wool or fiberglass batting decoupling layer on the other side. Inner face covered with fiber scrim reinforcing. Minimum 1lb. per square foot weight. Acoustical performance at least that of the design make.
 - 1. Basis-of Design Products: Kinetics Noise Control, Inc.; Type KNM-100ALQ and Sound Seal; B-10 LAG.
- C. Damping Compound: Non-asphaltic viscoelastic vinyl based latex emulsion designed for application to metal surfaces for the purpose of damping acoustical vibrations and with damping efficiency at least that of the design make.
 - 1. Basis-of Design Products: Kinetics Noise Control, Inc.; Type KDC-E-162 and Sound Seal; VBD-10.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and movement control devices for compliance with requirements for installation tolerances and other conditions affecting performance. Notify affected Prime Contractors and Architect in writing of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in an acceptable manner.
 - 1. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
 - 2. Identify any discrepancies between specifications and field conditions or changes required due to specific equipment selection, prior to installation. Corrective work required by discrepancies after installation at Contractor's expense.
- B. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 VIBRATION, SOUND, AND THERMAL MOVEMENT CONTROL INSTALLATIONS

- A. Install all vibration isolators and acoustical attenuators in strict accordance with manufacturers written instructions and all submittal data. Coordinate installation to avoid rigid contact with building.
 - 1. Install without any change of position of equipment, piping or ductwork resulting in stresses or misalignment.
 - 2. Do not make rigid connections between equipment and building structure that degrade noise and vibration control system specified.

3. Do not install any equipment, piping, duct, or conduit with rigid connections to building or other support structure unless no isolation is specifically called for. "Building" includes, but is not limited to, roof deck, floor/ceiling/roof slabs, beams, joists, columns, studs and walls.
4. Identify any conflicts which will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions to Architect / Engineer prior to installation. Corrective work required by conflicts after installation at Contractor's expense.
5. Correct, at no additional cost, all installations deemed defective in workmanship and materials at Contractor's expense.

3.3 PIPED EQUIPMENT INSTALLATIONS

A. Condensing Units:

1. Isolate equipment from structure using vibration isolation system specifically designed for the installation and having deflection tuned to the mass and frequency of the rotating or vibrating machinery to minimize the propagation of the vibrations.
 - a. Unless specifically detailed otherwise, isolate equipment having 1 KW motors and larger and/or having a rotating speed of any component under 1800 rpm using restrained spring isolators with minimum 2" deflection, on inverted saddles as required to lower height, all mounted on elastomeric pads.
 - b. Unless specifically detailed otherwise, isolate equipment having under 1 KW motors and having a rotating speed of all components 1800 rpm or over using restrained elastomeric isolators with minimum 0.3" deflection, on inverted saddles as required to lower height.
 - c. When installed indoors above occupied space, include floating concrete isolation base.

B. Hydronic Equipment

1. All base mounted pumps 1hp and larger installed above occupied spaces (including roof mounted pumps): Install on floating concrete isolation bases.
2. Vibration Isolation of Hydronic Equipment:
 - a. Isolate all upper floor, suspended, and roof mounted hydronic equipment with vibration producing parts from structure using vibration isolation system specifically designed for the installation and having deflection tuned to the mass and frequency of the rotating or vibrating machinery so as to minimize the propagation of the vibrations.

- b. Where piping connects to mechanical equipment with vibration producing parts, including air-handling equipment with hydronic or refrigerant based heat exchange coils, install elastomeric spherical or mechanical coupling flexible connection joints.
 - 1) Where elastomeric based flexible connector joint is not suitable for service (example: refrigerant service), provide flexible stainless steel hose. Install hoses:
 - a) On equipment side of shut-off valves.
 - b) Parallel to rotating equipment shafts, wherever possible.
 - c) Perpendicular to anticipated thermal movement.
 - d) Where movement in two axes is anticipated, install hose of sufficient length to form elbow or install two hoses with elbow fitting between.

C. Piping Installations:

- 1. Vibration and Acoustical Isolation of Piping: Locate isolation hangers as near to overhead support structure as possible.
 - a. Horizontal Pipe Isolation
 - 1) Provide Type B hangers and/or restrained mountings for first 2 pipe hangers in lines near chillers, heat exchangers, pumps, and risers.
 - a) Provide restrained spring mountings for similar floor supported piping.
 - b) Provide same static deflection as specified for mountings under connected equipment, minimum 1 inch near chillers and pumps.
 - b. Riser Isolation
 - 1) Suspend risers from Type A hangers or supported with spring isolator mountings, guided with sliding pipe guides.
 - 2) Provide minimum 0.75-inch steel spring deflections, except in those expansion locations where additional deflection is required to limit load changes to +/-25 percent of initial load.
 - 3) Include riser diagrams and calculations in submittals showing anticipated expansion and contraction at each support point, initial and final loads on building structure and spring deflection changes. Include certification that riser system has been examined for excessive stresses and that none will exist in proposed design.
- 2. Vibration and Acoustical Isolation of Piping Penetrations: Where piping passes through structure, use Split Wall Seals specified in Part 2 above.

3. Install expansion loops where shown on drawings and in all straight piping runs eighty (80) feet long and longer, at least one (1) expansion loop per one hundred twenty (120) feet of straight run. Install anchors and pipe alignment guides for each expansion loop in accordance with manufacturer's recommendations, with anchor and guide bases as specified in Section 23 05 29 - Hangers and Supports for HVAC Components".
4. Thermal Movement Isolation: Where piping with anticipated thermal movement is connected to fixed location equipment (for example, duct coils near main HWS&R, unit ventilators above crawl-space mains just below, etc.), provide flexible hoses perpendicular to motion rated for total expected movement. Anticipate movement and install so flex hose will be nominally straight at normal operating temperature.

3.4 AIRSIDE INSTALLATIONS

A. Vibration Isolation of Air Handling Equipment:

1. Isolate all suspended air handlers using Type B hangers with minimum 2 inches spring deflection for units having 1/2 KW motors and larger and with minimum 1 inch spring deflection for units having less than 1/2 KW motors.
2. For all roof top air handlers above occupied spaces unless otherwise noted or scheduled on drawings, provide acoustical attenuation within curb below rooftop air handlers as follows:
 - a. Coat deck within curb with damping compound.
 - b. Seal around duct, pipe, conduit, fastener, etc., penetrations air-tight to maintain air and vapor barrier, typically with 60mil EPDM roofing membrane sealed to deck and cut for a tight stretch fit to pipe or duct. Caulk holes. Fill deck corrugation flutes at edges with fire rated expanding urethane foam and set / seal EPDM into wet foam.
 - c. For air handlers with total motor power less than 5KW unless specified otherwise on the drawings:
 - 1) Fill entire area within curb with fire rated expanding urethane foam to a minimum depth of 5 inches from the top of the deck flutes.
 - d. For air handlers with total motor power 5KW and above and/or as specifically called for on the drawings:
 - 1) Overlay sealed deck with 3" flexible fiberglass batt insulation.
 - 2) Overlay insulation with one layer of 5/8" thick moisture and mold resistant gypsum board (GWB) fitted 1" from curb perimeter and duct/piping penetrations with annulus filled with fiberglass batt, sealed and taped at all joints with damping compound and skrim joint tape.

- 3) Overlay GWB with acoustical duct/pipe lagging fitted closely to duct, pipe, and curb perimeter and seal to each in accordance with manufacturer's directions.
- 4) Provide acoustical duct and piping penetrations both through unit bottom and roof deck.

B. Vibration Isolation of Ductwork:

1. Isolate all ducts from mechanical air handling equipment using flexible connectors.
2. Isolate all discharge runs for distance of 50 ft. from connected equipment from building structure using Type A or Type B hangers or spring floor isolators. Provide minimum of 0.75-inch spring deflection.
3. Isolate all rectangular duct runs having average air velocity of 1200 fpm or more from building structure using Type A or Type B hangers or spring floor supports. Provide minimum of 0.75-inch spring deflection.
4. Unless internally lined, provide damping compound on all rectangular duct hung over occupied spaces and having average air velocity of 1000 fpm or more as required to eliminate duct rumble.

C. Vibration and Acoustical Isolation of Duct Penetrations: Where duct passes through acoustically sensitive structure (walls, floors, roof, and / or ceilings), and where noted on Drawings to provide sound attenuated penetration, provide damping compound for two feet on either side of wall, insulate per Section 23 07 00, then pack gap between insulation and general construction wall materials with mineral wool and seal with damping compound.

1. Coordinate this requirement with any fire rating of the wall and maintain both fire rating and acoustical separation with UL listed assembly.
2. Acoustically sensitive structure penetrations include:
 - a. All walls/ floors/ ceilings of mechanical rooms.
 - b. Ceiling / roof deck at all roof top air handling units.
 - c. Rooms with substantial noise generated within, such as woodworking, technology, music rooms, etc.
 - d. Rooms that require acoustical privacy such as auditoriums and administrative offices.

3.5 ADJUSTING

- A. Adjust isolators after piping system is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

- C. Adjust active height of spring isolators.
- D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 23 05 43

SECTION 23 05 48 – MECHANICAL WIND LOAD CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes control of mechanical component movement resulting from wind generated loads. Controls for all mechanical equipment and components, piping, and duct work provided or modified as a part of this Project and as noted on the drawings are included.
- B. Considering that the basis of design equipment is not always provided for project work, and that not all acceptable “equals” are the same weight, size, center of mass, cross section profile, and other characteristics that affect the wind load calculations, these detailed calculations are to be performed once specific to the approved mechanical equipment as part of a delegated design as detailed below.
- C. Control of mechanically generated vibrations and sounds and control relative movement of components due to thermal expansion and contraction are covered in Section 23 05 43 – Mechanical Vibration and Movement Control.
 - 1. Securing those vibration and movement control components against wind loads is covered in this section.
- D. Specialized movement control components specified in this section include:
 - 1. Wind restraints and snubbers.
 - 2. Wind restraint construction requirements.

1.3 DEFINITIONS

- A. IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.

1.4 WIND RESTRAINT PERFORMANCE REQUIREMENTS

- A. Provide restrained mechanical sound, vibration, and movement control for all mechanical equipment, piping, duct work, and other components provided or modified as a part of this Project, and as shown on the Drawings. Coordinate restraints with vibration and movement control system described in Section 23 05 43 – Mechanical Vibration and Movement Control.

- B. Provide complete design, detailing, and design documentation of all wind restraints required and exceptions allowed, for all mechanical equipment, piping, duct work, and other components provided or modified as a part of this Project and as shown on the Drawings, allowing all restrained components to withstand wind forces specified. Design shall be performed by a qualified licensed and registered professional engineer, with all drawings, calculations, and design analysis data signed and sealed by the engineer responsible for their preparation.
- C. Design in accordance with the mechanical component wind design requirements of the Building Code of New York State and applicable local codes. Calculations and design to be based on the following criteria.
- D. Wind-Restraint Loading:
 - 1. Refer to structural drawings for design requirements.

1.5 SUBMITTALS

- A. General: Submit all action submittals and informational submittals required by this Section concurrently.
- B. Action Submittals:
 - 1. Product Data for the following:
 - a. Catalog cuts and data sheets on wind restraint components used. Indicate style, material, rated strength in tension and shear, fastening provision, and finish for each device.
 - b. Schedule of flexibly mounted equipment, referencing drawings by number. Include number, type, and loading of all isolation components.
 - 2. Wind Restraint Delegated-Design Submittal:
 - a. Wind-Load Design Calculations: Submit all static and dynamic loading calculations prepared under "Wind-Load Design Calculations" Paragraph in "Performance Requirements" Article.
 - b. Qualified Professional Engineer: All designated-design submittals for wind-restraint calculations are to be signed and sealed by qualified professional engineer responsible for their preparation.
- C. Informational Submittals:
 - 1. Wind-Force Performance Certification: Provide special certification for HVAC components subject to high wind exposure and impact damage and designated on Drawings or in the Specifications to require wind-force performance certification.
 - 1) Provide equipment manufacturer's written certification for each designated HVAC device, stating that it will remain in place and operable following the design wind event and comply with all requirements of authorities having jurisdiction.

- 2) Provide manufacturer's written certification for each designated louver, damper, or similar device, stating that it will remain in place and protect opening from penetration of windborne debris and comply with all requirements of authorities having jurisdiction.
- 3) Certification must be based on ICC-ES or similar nationally recognized testing standard procedures acceptable to authorities having jurisdiction.
- 4) Retain subparagraph below only if wind-force performance certification is not scheduled on Drawings. If a schedule is not included on Drawings, all wind-force performance certified systems must be listed below. See "Special Certification" Article in the Evaluations for more information.
- 5) The following HVAC systems and components require special certification for high wind performance. Written special certification of resistance to the effects of high wind force and impact damage must be provided by manufacturer:
 - a) RCU's
 - b) PRE's
 - c) DOAS Units
 - d) Rooftop Units
 - e) Rooftop Ductwork
 - f) Or items on the roof that require wind design per code
2. Qualification Data for Professional Engineer: Document evidence of current New York State Professional Engineering Registration and provide references to three successful wind restraint design projects of comparable or greater scope to this project within the past three years.

D. Closeout Submittals:

1. Field quality-control test reports.
2. Contract Closeout Submittals: Comply with requirements of Section 01 73 00, including submission of operating and maintenance instructions as item in "General Construction Instructions" manual described in that section.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent Testing Agency, with the experience and capability to conduct the testing and inspecting indicated as documented according to ASTM E 329, that is either a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, or accredited according to NIST's National Voluntary Laboratory Accreditation Program (NVLAP), and that is acceptable to authorities having jurisdiction.
- B. Professional Engineer Qualifications: Professional engineer legally qualified to practice in the jurisdiction where the Project is located and experienced in providing engineering services of the kind indicated, including (but not limited to) design and installation of vibration isolation bases and wind restraints similar in material and extent to those indicated for this Project.

- C. Comply with the more stringent of the wind-restraint requirements in the Building and Mechanical Codes of New York State, Local Codes and Ordinances, the Authority having jurisdiction, or the requirements in this Section.

1.7 COORDINATION

- A. Coordinate layout and installation of wind load control devices with other construction that penetrates ceilings or is supported by, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.
- C. Coordinate design of restraints and vibration isolation design with expansion compensation systems.

PART 2 - PRODUCTS

2.1 WIND LOAD RESTRAINT DEVICES

- A. Wind load restraint devices may include all restraint devices listed above as approved and as included in the delegated design wind restraint calculations submittal, as well as any other custom wind restraint devices designed and approved by delegated design engineer which are required above and beyond specified wind restraint system.
- B. Wind-Load Design Calculations:
 - 1. Perform calculations to obtain force information necessary to properly select wind-load-restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in most current version of ASCE/SEI 7. Where "ASCE/SEI 7" is used throughout this Section, it is to be understood that the edition referred to in this subparagraph is intended as referenced throughout the Section Text unless otherwise noted.
 - a. Data indicated below that are specific to individual pieces of equipment must be obtained by Contractor and must be included in individual component submittal packages.
 - b. Coordinate design wind-load calculations with wind load calculations for equipment requiring wind-load reinforcement. Comply with requirements in other Sections in addition to those in this Section for equipment mounted outdoors.
 - 2. Refer to structural drawings for design criteria.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive wind control devices for compliance with requirements for installation tolerances and other conditions affecting performance. Notify affected Prime Contractors and Architect in writing of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in an acceptable manner.
 - 1. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
 - 2. Identify any discrepancies between specifications and field conditions or changes required due to specific equipment selection, prior to installation. Corrective work required by discrepancies after installation at Contractor's expense.
- B. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 WIND RESTRAINT INSTALLATIONS

- A. General Wind Restraint Requirements:
 - 1. Provide complete wind restraint system as specified and as shown and detailed on approved delegated design submittals.
 - 2. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
 - 3. Install restraint devices in strict accordance with the approved Installation Quality Control Procedure and other applicable submittal data, using methods approved by an evaluation service member of ICC-ES, OSHPD, or required submittals for component.
 - 4. Strength of Support and Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and wind loads within specified loading limits.
 - 5. Install cables so they do not bend across edges of adjacent equipment or building structure.
- B. Equipment Restraints:
 - 1. Snubbers: Install the required number of snubbers on each spring-mounted piece of equipment. Locate snubbers as close as possible to the vibration isolators and bolt to equipment base and supporting structure.
 - 2. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolts and mounting hole in concrete base.

3. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
4. Vibration Isolation Bases: Mount equipment on structural-steel bases or concrete inertia bases.

C. Piping Restraint:

1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c., or closer as detailed in delegated design.
3. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application.
4. Brace at change of direction longer than 12 feet.

D. Structural Attachments:

1. All welding shall be by qualified welders using qualified procedures.
2. If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
3. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
4. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
5. Wedge Anchors: Protect threads from damage during anchor installation. Install heavy-duty sleeve anchors with sleeve fully engaged in the structural element to which anchor is to be fastened.
6. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
7. Set anchors to manufacturer's recommended torque, using a torque wrench.
8. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.3 FIELD QUALITY CONTROL

A. Contractor Requirements:

1. Testing Agency: Engage the services of a qualified Testing Agency to perform Tests and Inspections.
2. Provide access to all places of inspection for representatives Testing Agency(s).
3. Schedule tests with Owner's Project Representative, and Architect, before connecting anchorage device to restrained component (unless post-connection testing has been approved), and with at least seven days' advance notice.
4. Obtain Architect's approval before transmitting test loads to the structure. Provide temporary load-spreading members as required by the test loads.
5. Perform the following Tests and Inspections:
 - a. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 - b. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
 - c. Test to 90 percent of rated proof load of device.
 - d. Measure isolator restraint clearance.
 - e. Measure isolator deflection.
 - f. Verify snubber minimum clearances.
 - g. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.
 - h. Prepare test reports and distribute to Owner and Architect.
6. Remove and replace malfunctioning units and retest as specified above.

B. Remove and replace malfunctioning units and retest as specified above.

C. Walk-through with Owner's Project Representative, Professional Engineer responsible for design of wind restraints, and Restraint Manufacturer's Representative to verify installation is in accordance with specifications and submittals. Provide manufacturer approval letter and Professional Engineer-stamped letter documenting installation is complete and approved by them as in compliance with Project requirements.

D. Owner's Testing Agency: Will perform inspections and tests as required by applicable codes and insurance regulations. Make any corrections as required to meet Owner's Testing Agency's requirements.

END OF SECTION 23 05 48

SECTION 23 05 53 - IDENTIFICATION FOR HVAC COMPONENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Duct labels.
 - 5. Stencils.
 - 6. Valve tags.
 - 7. Equipment Location Ceiling Markers

1.3 SUBMITTALS

- A. Procedural Requirements: Comply with requirements of Section 01 33 00 - Submittals and as modified below.
 - 1. Specified Products: If product to be incorporated into Project is specified by name and product designation in Part 2 below, submit “**As-Specified Verification Form**” (attached to Section 01 33 00 - Submittals) in lieu of “Product Data” identified below in this Article.
 - 2. Equivalent Products or Substitutions: If product to be incorporated into Project is not specified by name and product designation in Part 2 below, comply with all Action Submittal requirements specified below.
- B. Action submittals:
 - 1. Submit manufacturer’s data sheets for all proposed products demonstrating compliance with specifications.
- C. Closeout Information, for inclusion in Operations and Maintenance Manual:
 - 1. Approved submittal.
 - a. If “**As-Specified Verification Form**” submittal is approved, also include product data for all identification components used.

2. Include all information required in Section 01 78 23 – Operation and Maintenance Data.
3. Valve Chart - Refer to Section 23 05 00 – Common Work Results for HVAC, for details.

1.4 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Paint: Refer to DIVISION 09.
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Brimar Industries, Inc. or equal.
 2. Campbell International (Ltd.), or equal.
 3. Craftmark Identification Systems, Fort Worth, Texas, or equal
 4. EMED Company, Inc., Buffalo, New York , or equal
 5. Seton Name Plate Company, New Haven, Connecticut, or equal

2.2 LABELS

- A. Warning Signs and Equipment Labels:
 1. Material and Thickness: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware, or multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware
 2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 3. Colors:
 - a. Brass Labels: black in-filled letters on brass background
 - b. Plastic Labels: white letters on black plastic background
 - c. Warning Signs: yellow letters on black background.
 4. Able to withstand temperatures up to 160 deg F. continuously.

5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 6. Fasteners: Stainless-steel rivets or self-tapping screws.
 7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Equipment Label Content: Include equipment's Drawing designation or unique equipment number and equipment function.
 - C. Warning Sign Content: Include caution and warning information, plus emergency notification instructions.
 - D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Include Equipment Schedule in Operation and Maintenance Manual.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive. Secure in place with full circumference tape wrap.
- C. Pipe Label Contents: Include identification of piping service using abbreviations indicated below, pipe size, and an arrow indicating flow direction.
 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction (flow direction arrow circumference tape preferred).
 2. Lettering Size: In accordance with ANSI 13.1 and as follows:

Outside diameter:	Letter Height:
a. 2" or less	3/4"
b. 6" or less	1.25"
 3. Pipes too small to be directly labeled: provide hanging equipment tag with 1/2" lettering. Outside diameter indicated is to outside of pipe insulation on insulated piping.

D. Piping Systems: Identify the following systems as indicated:

1. Refrigerant Liquid (RL)
2. Refrigerant Suction (RS)
3. Refrigerant Hot Gas (HG)
4. Heating Hot Water Supply (HWS)
5. Heating Hot Water Return (HWR)
6. Natural Gas (G)
7. Pumped Condensate (PC)
8. Condensate Drain (CD)
9. Make up water (MU)
10. Boiler Blow Down (BBD)

2.4 DUCT LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- B. Colors: Letter color, black; background color, white.
- C. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- D. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- E. Minimum Letter Size: One inch for viewing distances up to 60 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- F. Fasteners: Stainless-steel rivets or self-tapping screws.
- G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- H. Duct Label Contents: Include identification of duct service, duct size (inches x inches clear inside dimensions, side labeled first), and an arrow indicating flow direction.
 1. Unless specifically indicated otherwise on Drawings, use duct service designations below, where (SYSTEM) is the equipment served:
 - a. (SYSTEM) SUPPLY AIR
 - b. (SYSTEM) RETURN AIR
 - c. (SYSTEM) RELIEF AIR
 - d. (SYSTEM) OUTSIDE AIR
 - e. (SYSTEM) MIXED AIR
 - f. (SYSTEM) MIXED EXHAUST
 - g. (SYSTEM) TOILET EXHAUST
 2. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.

2.5 STENCILS

- A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches for ducts (1 inch for each five feet viewing distance).
 - 1. Stencil Material: Durable, thin, as required to make crisp stenciled pattern.
 - 2. Stencil Paint: Exterior, gloss, acrylic enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
 - 3. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated.
 - 4. Stenciled Label Contents: as described in pipe and duct labels above.

2.6 VALVE TAGS

- A. Valve and Hydronic Specialty Identification: Provide 1-1/2-inch diameter brass tags, 0.032-inch minimum thickness, with predrilled or stamped holes for attachment with #16 brass jack chain, factory engraved or stamped with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers, with black in fill, legend as described below.
 - 1. Stamp "H" and valve number for each main, riser, zone, and branch heating valve.
 - 2. Stamp "H" (for heating) plus "S" and strainer number for each strainer.
 - 3. Stamp "H" (for heating) plus "B", and valve number for all manual balancing valves. Provide manufacturer's tags for all automatic balancing fittings.
 - 4. Provide a special tag at thermal expansion tank(s) shut off valve with legend as follows: "Always keep this valve open except when draining tank".

2.7 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
 - 1. Size: 3 by 5-1/4 inches minimum.
 - 2. Fasteners: Brass grommet and wire.
 - 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 - 4. Color: Yellow background with black lettering.

2.8 EQUIPMENT LOCATION CEILING MARKERS

- A. 5/8-inch diameter celluloid covered or vinyl PSA backed stickers, suitable for ink notation on a colored face; color coded as follows:
 - 1. Yellow: Volume Dampers
 - 2. Blue: Isolation Valves
 - 3. Green: Controls Devices (valves, automatic dampers, controllers)
 - 4. Orange: Equipment (fan coils, fans, pumps, etc.)
 - 5. Red: Fire Dampers

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.
- B. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.3 PIPE IDENTIFICATION

- A. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels with painted, color-coded bands or rectangles and flow direction arrows, complying with ASME A13.1, on each piping system. Stencils shall be crisp and neat with no overspray, drips, runs, or other imperfections visible from normal viewing distance.
 - 1. Identification Paint: Use for contrasting background.
 - 2. Stencil Paint: Use for pipe marking.
- B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 15 feet along each run.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- C. Piping Painting Requirements:
 - 1. Refer to Section 23 05 00 – “Common Work Results for HVAC” and Division 09 sections covering painting for pipe painting requirements and Pipe Color Code Identification Schedule.

3.4 PIPE LABEL INSTALLATION

- A. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels on each piping system.
 - 1. Identification Paint: Use for contrasting background.
 - 2. Stencil Paint: Use for pipe marking.
- B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 15 feet along each run.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

3.5 DUCT LABEL INSTALLATION

- A. Install plastic-laminated duct labels with permanent adhesive on air ducts.
- B. Stenciled Duct Label Option: Stenciled labels, showing service, size, and flow direction as indicated above, may be provided instead of plastic-laminated duct labels, at Installer's option, for concealed ductwork or if lettering larger than 1 inch high is needed for proper identification because of distance (over ten feet) from normal location of required identification. Stencils shall be crisp and neat with no overspray, drips, runs, or other imperfections visible from normal viewing distance. Refer to Division 09 sections on painting for more information.
- C. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.6 VALVE-TAG INSTALLATION

- A. Install tags on new valves, hydronic specialties, and control devices in piping systems. Verify existing valve numbers in field and provide valve numbering avoiding duplication of existing numbers.
- B. Valve Identification Chart: Refer to Section 23 05 00 – “Common Work Results for HVAC” for Valve Identification Chart requirements.

3.7 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

3.8 EQUIPMENT LOCATION CEILING MARKERS

- A. Provide markers in the metal grid of lay-in tile, in metal panel ceilings, at access doors in hard ceilings, and other locations as appropriate, indicating the location of dampers, valves, controls, equipment, fire dampers, and other devices as required. Write on markers with sharply contrasting permanent ink in neat handwriting clearly identifying equipment located beyond mark with abbreviation used in valve chart, equipment schedule, etc.

END OF SECTION 23 05 53

SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Testing, Adjusting, and Balancing (TAB) Work shall be a joint effort of the Contractor and the TAB Agency, performed with the intention of leaving the systems involved in a properly functioning and balanced flow condition as designed and indicated in the Construction Documents, similar to the "Total System Balance" condition described in the AABC Standard.
 - 1. The division of responsibility for the TAB Work is outlined below. Contractor to perform preparation and ancillary work described below, with the option of subcontracting a portion of their work to the TAB Agency, but the TAB Agency must take sole responsibility for any portion of the preparation or TAB Work defined as the TAB Agency's Work.
 - 2. TAB Agency Work to be performed by a fully qualified independent TAB Agency as described in quality assurance below and as approved by the Architects and Engineers, to be paid for by the Owner under a separate Professional Services Contract.
- B. Section includes preparation for, and Testing, Adjusting, and Balancing (TAB Work) of HVAC components, equipment, and systems:
 - 1. Contractor Preparation and Participation:
 - a. Place systems in satisfactory operating condition as detailed below prior to the arrival of the TAB Agency for the specified TAB Work, and notify the TAB agency, Construction Manager, and Engineer in writing when systems are ready for TAB Work.
 - b. Attend and actively participate in coordination and TAB meetings.
 - c. Keep TAB Agency apprised of construction schedule as required facilitating TAB agency job site visits prior to concealment of work. Provide overall construction schedule to TAB agency at coordination meetings and TAB meetings, update schedule regularly noting milestones and dates affecting TAB review and work schedule, and provide at minimum 7 calendar days notice prior to concealment.
 - d. Coordinate and provide mechanical and controls systems operation, revisions, and other ancillary work as required during TAB Work, as detailed below.

- e. Make changes as required to create a testable, balanceable system, as recommended by TAB agency but only as approved by the Engineer.
2. TAB Agency Preparation:
- a. Review Construction Documents and Coordination Drawings with Engineer, Construction Manager, and Contractor and assist in preparation of submittals, particularly Coordination Drawings, dampers, and balancing valves, by preparing recommendations to Contractor and Engineer on locations of balancing valves, dampers, access doors, test connections, etc., as well as any other special considerations affecting the TAB Work and/or the fabrication or engineering of the systems. Documentation of assistance shall be both by mutually agreed upon notations on the submittals / sheet metal Shop Drawings prior to submittal, and by TAB Agency's letter accompanying submittal, verifying review and TAB Agency approval of the specific submittal.
 - b. Visit job prior to concealment of work, repeatedly if necessary due to construction scheduling, check work, and advise the Contractor, Construction Manager, and Engineer on correctness of locations of dampers, access doors, test connections, etc., as well as any other special considerations affecting the TAB work. Advise in writing, copied to the Contractor, Construction Manager, and the Engineer within 3 days of the site visit but in any event before concealment.

C. TAB Work includes:

- 1. *Testing* of all mechanical components for performance, calibration, capacity, and other characteristics as outlined below and as required, demonstrating conformance with contract documents and submittals.
- 2. *Adjusting and Balancing* of all mechanical components of this project as described in the contract documents, achieving specified air and water flow at all terminal equipment, distribution at lowest noise levels and energy use, and achieving specified thermometer, gauge, and sensor instrument accuracy and calibration, all as outlined below.
- 3. Documentation, correspondence, data recording, reporting, and demonstration all as outlined below and elsewhere in the contract documents.
- 4. *Coordination* with other Contractors, subcontractors, Construction Manager, Owner's Representatives, and Architect / Engineer as required achieving specified TAB results.

1.3 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. ASHRAE: American Society of Heating, Refrigerating, and Air-Conditioning Engineers
- C. Contractor: The entity contracted to perform the HVAC Work described in these contract documents.
- D. NEBB: National Environmental Balancing Bureau.
- E. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
- F. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.

- G. TAB: Testing, adjusting, and balancing.
- H. TABB: Testing, Adjusting, and Balancing Bureau.
- I. TAB Agency: An entity engaged to perform TAB Work who is qualified and approved to do so as described below.

1.4 SUBMITTALS, GENERAL

A. Contractor:

1. Perform no work affecting TAB prior to TAB Agency approval.
2. Prior to submittal of any equipment affecting TAB, review with approved TAB Agency and obtain commentary and approval as described in "Summary" Article. Include TAB Agency review commentary with affected submittals.
3. Immediately upon approval of other submittals, provide the TAB Agency with copies of approved submittals, including Shop Drawings of all hydronic and air systems and equipment requiring balancing.

1.5 ACTION SUBMITTALS

A. Contractor:

1. Within 30 days after award of Contract, submit TAB Agency qualifications proposal for approval.

B. Contractor and TAB Agency:

1. Submit Systems Readiness Reports as described more fully below.

C. TAB Agency:

1. Submit TAB Agency qualifications proposal for approval.
 - a. Name and contact information of proposed TAB Agency,
 - b. Documentation that they meet the qualifications specified in "Quality Assurance" Article, Evidence of current TAB Agency and TAB Supervisor Certification, Examples of data forms proposed for each system type showing input cells for this Project's required data, 3 regional references for comparable recent jobs.
 - c. List of instruments to be used in testing and balancing, with current certification of all instruments' calibration on calibration agency letterhead, including the following information:
 - 1) Instrument type and make.
 - 2) Serial number.
 - 3) Application.
 - 4) Dates of use.
 - 5) Dates of calibration.
 - 6) Test data points over range qualified – standards and measured values.

2. Submit Strategies and Procedures Plan: Within 30 days of Architect's approval of TAB Agency, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
3. Submit Preliminary Partial TAB Reports.
4. Submit Certified Final TAB Report.
5. Certified Six Month System Check / Design Condition TAB Report.

1.6 INFORMATIONAL SUBMITTAL

A. TAB Agency:

1. Contract Documents Examination Report: Within 15 days of Architect's approval of TAB Agency, submit the Contract Document Examination Report as specified in Part 3.
2. Include commentary with all Contractor submittals affecting TAB work as described above.
3. Pre-Construction Inspection and Testing Report: Prior to removal of any affected construction.

1.7 QUALITY ASSURANCE

A. TAB Agency, Employee, and TAB Work Qualifications:

1. TAB Agency: Fully certified current member of "Associated Air Balance Council" (AABC), "National Environmental Balancing Bureau" (NEBB), or "Testing, Adjusting, and Balancing Bureau" (TABB), specializing in the adjusting and balancing as specified in this Section of systems as specified and as shown on the Contract Documents, with minimum three years documented experience as a fully certified member, and three current regional references for projects of comparable scope.
2. TAB Field Supervisor: Employee of the TAB Agency and currently certified by AABC, NEBB, or TABB as a Testing, Balancing and Adjusting Supervisor.
3. TAB Technician: Employee of the TAB Agency and currently certified by AABC, NEBB, or TABB as a TAB technician.
4. All TAB Work: Performed by direct employees of the TAB Agency, who are either TAB Field Supervisors themselves, or who are TAB Technicians working under the direct supervision of a TAB Field Supervisor.

B. Conform to basic procedures and methods outlined by applicable publications in testing and balancing of air and water systems by the following organizations, and as modified by this document:

1. Associated Air Balance Council (AABC).
2. National Environmental Balancing Bureau (NEBB).
3. Testing, Adjusting, and Balancing Bureau (TABB).
4. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA)

5. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE)
 6. Individual manufacturer requirements and recommendations.
- C. TAB Conference: After approval of the TAB Strategies and Procedures Plan and before TAB Work begins, schedule and attend a meeting with Architect, Owner, and Construction Manager, at their convenience, to develop a mutual understanding of the details. Require the participation of the TAB Field Supervisor and Technicians. Provide seven days' advance notice of scheduled meeting time and location.
1. Agenda Items:
 - a. Review the Contract Documents examination report.
 - b. Review the TAB Strategies and Procedures Plan.
 - c. Review the System Readiness Report.
 - d. Coordination and cooperation of trades and subcontractors.
 - e. Coordination of documentation and communication flow.
- D. TAB Report Data Forms: Follow AABC, NEBB, TABB, or SMACNA format as modified by the data requirements of this Project, subject to submittal approval.
- E. Certify TAB field data reports and perform the following:
1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.
- F. Instrumentation Type, Quantity, Accuracy, and Calibration: Instruments as described in ASHRAE 111, Section 5, "Instrumentation.", all currently certified as calibrated by a NRTL or NVLAP in accordance with Division 01 Section "Quality Requirements".
- G. Contractor: maintain qualified personnel at Project for system operation, trouble-shooting, making system changes, and performing mechanical adjustments in conjunction with TAB procedures.

1.8 PROJECT CONDITIONS

- A. Full Owner Occupancy: Owner will occupy the site and existing building during the entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.
- B. Environmental Requirements: Accomplish TAB work under appropriate outdoor temperature conditions. Coordinate with Temperature Controls Contractor to manipulate HVAC systems as required to simulate design conditions for load testing boilers, chillers, terminal load equipment, and similar portions of the systems.
- C. Concealed Conditions: Before concealment of systems, verify and advise on type and location of balancing devices and test points. Make changes as required to balancing facilities.

1.9 COORDINATION AND SCHEDULING

- A. Refer to Division 00 and Division 01 for overall project sequencing and scheduling requirements. All HVAC work required for, and, approvable balancing in accordance with the requirements of this section is required to be complete before Contract Substantial Completion.
1. Contractor:
 - a. Assure that all HVAC work required to properly and completely test and balance the various systems, occurs in a timely fashion coordinated with the overall project schedule as required, with final readiness report delivered at minimum two calendar weeks prior to contract scheduled Substantial Completion Dates.
 - b. For HVAC Work required to be performed simultaneous with TAB Work, coordinate schedule with TAB agency and provide qualified staffing as required keeping pace with TAB agency personnel.
 - c. For phased projects prepare phased partial readiness for TAB coordinated with TAB Agency as required meeting the Owner's construction schedule.
 - d. Coordinate and report partial systems readiness in writing to TAB agency, Construction Manager, and Engineer, to allow TAB work to proceed in an orderly fashion.
 2. TAB Agency:
 - a. Assure that all TAB Work and all subsequent reporting on same occurs in a timely fashion coordinated with the overall project schedule prior to contract scheduled Substantial Completion Dates.
 - b. For HVAC Work required to be performed simultaneous with TAB Work, coordinate schedule with Contractor and provide qualified staffing as required to complete TAB work and reporting within one calendar week of partial phased work readiness and within two calendar weeks of final HVAC systems readiness for TAB.
- B. Tab Agency: Coordinate, schedule, and run a TAB Strategies and Procedures meeting, with Contractor, Owner, Architect, Engineer, Controls Subcontractor, and Commissioning Agent all present. Provide TAB Plan and agenda in advance, and produce and distribute meeting minutes.
- C. Contractor and TAB Agency: Perform all examination and preparation work required and submit Systems Readiness Report(s) prior to beginning TAB work.
- D. Contractor and TAB Agency: After submission of Systems Readiness Report, coordinate and schedule all preparation and TAB work with each other, Owner, Architect/Engineer, Construction Manager, and Commissioning Agent. Notify O/AE/CM/Cx team of all scheduled TAB work test dates and times in writing with at least seven days' advance notice for each visit.
1. Cooperate with other contractors and affected subcontractors as required to provide complete and proper testing, adjusting, and balancing of HVAC systems.

- E. Accomplish TAB Work during construction period as soon as the systems are complete enough to perform TAB work. Coordinate with project phases and before Owner takes possession. TAB work and approval of at least partial pencil copy reports is required before Owner takes possession.
- F. Multiple visits will be required for phased construction in cooperation with construction schedule, with multiple “pencil copy” submittals of partial TAB reports required promptly as each phase of TAB work is accomplished.
- G. Perform balancing for record at final stage when all previously completed sub-systems are checked and re-balanced to design performance.
- H. Contractor and TAB Agency: return to the site approximately six months after initial TAB Work is complete to perform system checkup and design condition rebalancing as defined below.
- I. Contractor and TAB Agency are subject to recall to site to verify report information before acceptance of the report by the Architect.
- J. Contractor: provide 2 additional copies of Shop Drawings and other submittals for all equipment and systems to be tested and balanced to TAB Agency as soon as possible but no later than 60 days prior to scheduled completion of equipment and systems installation.
- K. TAB Agency:
 - 1. Verify that Contractor has placed all systems and equipment in satisfactory operating condition as required allowing TAB Work to be properly performed.
 - 2. Cooperate with Contractor and affected subcontractors as required to provide complete and proper testing, adjusting, and balancing of air and water systems.
 - 3. Visit Project prior to concealment of Work and note location of dampers, test connections, and similar items. Record this information, transmit to Contractor, and incorporate on Record Drawings.
 - 4. Coordinate timing of six month system check and design condition TAB Work with weather, Contractor, and Owner.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- A. TAB Agency: Provide tools, ladders, recording meters, gauges, thermometers, velometers, anemometers, Pitot tubes, inclined gauge manometers, magnehelic gauges, amprobes, voltmeters, psychrometers, tachometers, ultrasonic or other non-intrusive flowmeters, sound meters, and all other instrumentation required to perform specified TAB work. Accurately calibrate all instruments.

1. Make instruments available to Architect to facilitate spot checks during testing and back-checking.
2. Provide additional balancing devices as required.

PART 3 - EXECUTION

3.1 EXAMINATION

A. By TAB Agency:

1. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
2. Visit Site and examine existing systems before construction and new / re-worked systems prior to concealment of construction to check on and advise regarding location of installed balancing devices, such as test ports, gage cocks, thermometer wells, thermometers and gages, flow-control devices, balancing valves and fittings, volume dampers, test connections, etc. Verify that locations of these balancing devices are accessible. TAB Agency shall advise Contractor and Architect of TAB Agency findings by letter.
3. Examine the submittals for HVAC systems and equipment. Verify that proposed equipment can be balanced as specified and as required. Provide commentary on all submittals advising where additional balancing devices are needed or configuration adjustment is desired to facilitate TAB work.
4. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
5. Examine test reports specified in individual system and equipment Sections.
6. Examine manufacturer's equipment performance data including pump and fan curves.
 - a. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

B. By Contractor:

1. Examine systems and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections has been performed, and all TAB preparation as described in "Preparation" Article is complete.

3.2 PREPARATION

A. TAB Agency:

1. Prepare and submit a TAB plan that includes the following
 - a. Site specific strategies narrative and step-by-step procedures with this project's equipment identified.
 - b. Instrumentation to be used.
 - c. Forms with specific identification for all equipment.
2. Prepare and submit a blank master Systems Readiness Report to Engineer, Commissioning Agent, and Contractors, with itemized checklists for each individual item to receive TAB Work as appropriate for the equipment, with a column for Contractor indicated status and another two columns with room for TAB Agency and Commissioning Agency commentary itemizing deficiencies discovered and confirming all systems preparation and examination has been properly performed. Include, at minimum, the following checks for each piece of equipment as applicable:
 - a. Air side:
 - 1) Verify required leakage and pressure tests on air distribution systems have been satisfactorily completed.
 - 2) Duct systems are complete with terminals installed.
 - 3) Volume, smoke, and fire dampers are open and functional.
 - 4) Automatic control system dampers are installed, adjusted, and operational, with actuators installed.
 - 5) Manufacturer's startup checklists have been appended.
 - 6) Clean filters are installed, temporary media obstructions are available.
 - 7) Fans are operating, free of vibration, and rotating in correct direction.
 - 8) Variable-frequency controllers' startup is complete and safeties are verified.
 - 9) Ceilings are installed.
 - 10) Windows and doors are installed.
 - 11) Suitable access to balancing devices and equipment is provided.
 - b. Hydronic and refrigerant piping side:
 - 1) Verify leakage and pressure/vacuum tests on distribution systems have been satisfactorily completed.
 - 2) Piping is complete with terminals installed.
 - 3) Water treatment is complete, and systems are flushed, filled, purged, and vented.
 - 4) Refrigerant systems are properly evacuated and filled with the correct refrigerant at the right pressure.
 - 5) Strainers are all clean.
 - 6) Manufacturer's startup checklists have been appended.
 - 7) Shutoff and balance valves have been verified to be 100 percent open.
 - 8) Pumps are started and proper rotation is verified.
 - 9) Pressure gauges, thermometers, and PT plugs are all installed where and as specified.
 - 10) Suitable access to balancing devices and equipment is provided.

c. Energy Management and Controls System:

- 1) Pressure, temperature, position, electrical current, and other controls system sensors are installed where and as specified.
- 2) Control valves, dampers, and variable-frequency controllers' are functioning in accordance with the sequence of operation.
- 3) Controllers are installed and functioning in accordance with the sequence of operation.

B. Contractor: Before TAB work commences on any portion of the system, and before new system startup, verify that systems are complete and in proper operating condition. Ensure the following:

1. Equipment is operable, in a safe and normal condition, and is of the size and capacity specified in the Contract Documents, bearings are greased, pulleys are aligned and belts properly tight, and equipment with functioning controls is ready for operation. Make any required modifications to systems in advance of the TAB Agency's arrival for that portion of the work.
2. Provide proper equipment start-up as specified, complete with manufacturer's filled out standard published start-up forms.
3. Temperature control systems are operable to the extent required for that portion of the TAB Work. Control valves must at least be installed complete and hand operable. Automatic dampers must be operable and under control. Safety interlocks and controls on HVAC equipment must be properly functional.
4. All motors, pumps, and fans have correct rotation.
5. Align belt driven fan drive systems. Align motor and fan shafts into parallel to within 1/4 degree. Align drive and driven pulleys into same plane to within 1/32 inch per foot of center to center distance. Adjust belt tension to within drive manufacturer's recommended tolerance, and securely lock all adjustment fasteners.
6. Permanent electrical-power wiring is complete, and proper thermal overload protection is in place for all electrical equipment.
7. All ductwork, air handlers, grilles, registers, and diffusers are installed, complete, and cleaned of dust and debris.
8. All piping, terminal radiation, boilers, chillers, heat exchangers, pumps, valves, required pressure taps, and hydronic specialties are correctly installed, complete, operational, and clean.
9. All ductwork, diffusers and registers have dampers where specified, and all hydronic systems have balancing and isolation valves where specified.
10. Hydronic systems have all required vents and drains installed and functional, and are flushed, vented, cleaned, leak free, and filled with specified heat transfer fluid.

11. Hydronic expansion tank has been pre-charged to the proper pressure and systems filled to proper cold fill pressure.
12. System pump suction piping is properly vented to ensure absence of entrained air.
13. All manually set dampers (fire, register, grille, diffuser, and manual volume dampers) operate smoothly and are adjusted open. All automatic dampers have actuators and required linkages installed and rough adjusted.
14. All hydronic systems valves are installed with proper direction of flow and operate smoothly, balancing valves are adjusted open, P-T plugs and gauges are installed and functional where required, two-way control valves are open, three-way valves are properly installed for their intended function of diverting or mixing fluid flows, and service valves are open or closed as required for normal flow.
15. Make preliminary adjustments to airflow patterns of all registers, grilles, and diffusers to obtain uniform space temperatures and air movement free from objectionable drafts and noise.
16. Clean new final design filters are installed everywhere called for.
17. Hydronic strainers are clean and any temporary screens are replaced with permanent screens. Sidestream filters have clean new filter bag installed and valves are closed.
18. Coil fins are clean and straight.
19. Access doors in ducts are closed and duct end caps are in place.
20. Access doors necessary to reach duct volume dampers, balancing valves, and measuring stations are installed in accessible locations and are operable.
21. As-built conditions are accurately recorded on working as-built drawings, including locations of all access points, manual and automatic dampers, isolation, balancing, and control valves, fittings, and all other items affecting TAB work. Provide copies of these annotated as-built drawings for TAB agency's use during TAB work.
22. As the various portions of the system are completed and become ready for TAB, prepare and submit partial Systems Readiness Reports to Engineer, Commissioning Agent, and TAB Agency, with itemized checklists filled out as appropriate for the equipment to receive TAB Work, indicating status and requesting TAB for that portion of work commence.
 - a. Include itemized list of all examination and preparation procedures outlined above and as otherwise required by TAB and Commissioning Agencies' procedures, with initialed dated verification of each item by authorized responsible party.
 - b. Promptly report abnormal conditions in mechanical systems or conditions that prevent system balance. If, for any reason, system cannot be properly balanced, report as soon as observed.

23. Report any additional defects or deficiencies observed during performance of TAB procedures.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. In the following TAB procedures portions of Part 3 Execution of this document, the procedures are deemed to be TAB Agency work unless specifically identified as Contractor work.
- B. Contractor required assistance and Ancillary Work during TAB Agency Work includes the following general work categories and notes on Contractor Work requirements in subsequent specific procedure descriptions:
 1. Maintain mechanically qualified personnel at Site to perform necessary mechanical modifications and adjustments in conjunction with TAB procedures.
 2. Operate systems.
 3. Provide trouble-shooting.
 4. Change and re-align pulleys, sheaves, belts, etc., as required to meet system performance requirements. Provide machined steel or cast iron sheaves of quality equal to OEM equipment, and cogged premium raw edge belts. Properly adjust belt tension. Maintain specified drive safety factor – do not reduce the size of the smaller sheave /pulley without explicit written approval of first manufacturer then engineer.
 5. Cut insulation, pipes, ducts, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures. Properly plug all holes. Provide new insulation that matches removed materials, finished in accordance with Division 23 Section "HVAC Insulation."
 6. Change air filters as required.
 7. Adjust automatic damper linkages so they all operate smoothly and close tightly.
 8. Perform necessary controls operations required for TAB procedures.
 9. Re-adjust / make final adjustments to registers, grilles, and diffusers in cooperation with Owner and TAB Agency as required to obtain uniform space temperatures and air movement free from objectionable drafts and noise. As this affects system pressure drops, this must be completed before final airflow balancing.
 10. Make any required additions or changes in types, locations, etc., of balancing equipment.
 11. Provide other mechanical adjustments as required in conjunction with TAB procedures.
 12. Leave system in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes and securing cover plates, restoring thermostats to specified settings, restoring systems to automatic operation as required, replacing ceiling tiles, plugging access ports and repairing insulation, cleaning, etc...

- C. Tab Agency: Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance", ASHRAE 111, NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems", or SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing", and in this Section.
1. Review, edit, and deliver annotated Contractors Systems Readiness Reports to Contractor, Engineer, and Commissioning Agent, with itemized TAB Agency concurrence or commentary, itemizing deficiencies discovered and confirming all systems preparation and examination has been properly performed, with initialed dated verification of each item by authorized responsible party.
 2. Provide all testing and Balancing as required by the specific procedures outlined below and as required to provide the final test report as described below.
 3. Mark equipment and balancing devices, valve position indicators, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
 4. Take and report testing and balancing measurements in inch-pound (IP) units unless otherwise directed.
 5. Promptly report abnormal conditions in mechanical systems or conditions that prevent system balance, for any reason including but not limited to installation, design, or Owner use reasons within 24 hours of discovery.
 6. Report any defects or deficiencies observed during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values. Include updates in partial TAB report submittals. Adjust as-built drawings as required to accurately reflect deviations from draft as-built set.

3.4 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

- A. Pre-Construction Testing of Existing HVAC Systems: Prior to system shut down, demolition and modifications associated with existing HVAC systems, and prior to submittal of any replacement equipment, provide testing and recording of existing system operating data as itemized below. Submit copies of existing system operating data to Architect for review. On completion of system modifications, confirm that new or modified system characteristics conform to original data or new requirements by taking new readings and readjusting systems as required.
1. (3) Boiler room base mounted system pumps.
 2. (2) Boiler room inline pumps that serve the domestic hot water storage tank.
- B. On systems where there are no HVAC component modifications or work other than possible TAB work shown on the contract drawings, no TAB work is required unless specifically called for on the drawings.

- C. On systems that are only partially modified, perform TAB work both before and after modifications as required to demonstrate that modified portions of the system are performing as required and unmodified portions of the system are still operating at least as well as they were prior to modifications. Also perform additional TAB work as specifically called for on the drawings.
- D. Perform the following operations:
 - 1. Hydronic systems:
 - a. Pumps: Check and record make and model; suction, discharge, and impeller size; pump discharge, suction and total head pressure; drive frequency if controlled by VFD, and gallons per minute delivery.
 - b. Balancing fittings: Check and record pressure drop, flowrate, and operating condition.
 - c. Control valves: pressure drop at flow measured at associate balancing fitting.
 - 2. Air Systems:
 - a. Fans: Check and record suction and discharge pressures, total cfm, rpm, drive data, and motor data.
 - b. Main branch ducts: Make pitot tube traverse and obtain cfm.
 - c. Return / outside air / total airflow cfm and associated damper positions in occupied and unoccupied operating modes.
 - d. Airflow at all inlets and outlets.
 - 3. Heat Transfer (heat exchangers, coils):
 - a. Inlet and outlet pressures, air and watersides.
 - b. Flowrate, air and/or water, heating and heated mediums.
 - c. Entering and leaving temperatures, both heating and heated mediums. Include wet bulb and dry bulb temperature for cooling coils.

3.5 GENERAL PROCEDURES: AIR SYSTEMS TESTING, ADJUSTING, AND BALANCING

- A. Visit Site prior to concealment of construction to check and advise regarding location of dampers, test connections, etc. TAB Agency shall advise Contractor and Architect of TAB Agency findings by letter.
- B. Review sheet metal shop drawings and mark locations of all required balancing dampers before duct fabrication.
- C. Re-check fan belt pulley alignment under properly tensioned condition, and report final tolerances and tension achieved. Direct re-alignment as required to achieve stated tolerances.

- D. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct in such a manner that local flow dynamics have a negligible effect on the measurements. Use multiple, bidirectional, traverses if flow measurements cannot be made in a section with at least 8 diameters straight duct upstream and 4 diameters of straight duct downstream from the measuring station. Mark all traverse locations on plans in report.
- E. After adjustments, take measurements to verify balance has not been disrupted. Verify that disruptions in balance have been corrected.
- F. Permanently mark valve, damper, and other adjustment device settings at devices to simplify restoration of settings. Record settings and include in report. Set and lock memory stops.
- G. Procedures:
 - 1. Verify that all systems are complete and operable as scheduled.
 - 2. Verify that registers, grilles, and diffusers are adjusted to obtain uniform space temperatures and air movement free from objectionable drafts and noise. Cooperate with Owner and Contractor and reach agreement on air distribution pattern before proceeding.
 - 3. Align belt driven fan drive systems. Align motor and fan shafts into parallel to within $\frac{1}{4}$ degree. Align drive and driven pulleys into same plane to within $\frac{1}{32}$ inch per foot of center to center distance. Adjust belt tension to within drive manufacturer's recommended tolerance. Re-check alignment under properly tensioned condition, securely lock all adjustment fasteners, and report final tolerances and tension achieved.
 - 4. Provide temporary filter media as follows: with the system fully operational, all dampers open, and the fan running at the scheduled RPM, check submittal values for new, midlife, and final/clogged filter pressure drops, check and record air pressure drop across the new clean final design filters, and provide temporary media to approximate midlife pressure drop across the filters for use during balancing. Record and report both pressure drop values at the final design flowrates. Adjust filter differential pressure switches to trip at correct final/clogged filter pressure drop in cooperation with Energy Management and Control System manufacturer's representative.
 - 5. With the system fully operational, all dampers open, and the fan running at the approved submittal RPM, measure the airflow through all terminal units as well as the total system volume, without making any adjustments, and formulate a plan for preliminary adjustments of dampers and fan speed. Terminal units shall be defined to include all diffusers, registers, grilles, duct entries, louvers, hoods, etc.; i.e., wherever air enters or leaves ductwork whether indoors or outdoors. Record and report all initial values.

6. In cooperation with Energy Management and Control System manufacturer's representative, make mechanical adjustments of automatically operated dampers to operate as specified, indicated, and/or noted. Adjust and set the extreme operating conditions of these dampers and check completed damper control operations for proper calibration, reporting to control installers conflicts with those requiring adjustment. Test leakage of closed dampers. Adjust and set intermediate positions of outside air and return air dampers as required to achieve design outside airflow requirements defined in the sequence of operations, and / or calibrate outside air flow meters at this point. Balance variable volume systems at maximum air flow rate with full cooling and at minimum air flow rate with full heating
7. Adjust terminal units to the proportionally correct cfm, not necessarily the design cfm.
 - a. If all the dampers in a branch line's terminal units must be adjusted to limit cfm, then use the branch line volume damper to limit the pressure drop across the terminal units in that branch so that at least one terminal unit's damper remains wide open but still has the correct flow. Adjust all branch ducts to proper proportional cfm in this way, leaving the volume dampers in the flow limiting branches wide open.
 - b. Provide branch duct volume control by duct internal devices such as dampers and splitters only to the extent that the most open damper or splitter remains wide open and adjustments do not create objectionable air motion or sound levels. Under no circumstances shall total air system volume be throttled back to design flow through the partial closing of all dampers and splitters.
 - c. Record and report all initial adjustment positions and proportional flowrates achieved.
8. Vary total air system flowrate by adjustment of fan speeds. Provide drive changes required.
 - a. For variable frequency drive fans, perform the following procedure:
 - b. With the VSD set to bypass mode or set at 60 Hz, adjust the fan belt drive system (if applicable) as described above to achieve the design system cfm, with bypass dampers etc. closed or otherwise in the maximum resistance position.
 - c. Adjust the VSD to the maximum non- overloading frequency for the system, and measure and report the flowrate at this frequency
 - d. If other specific air flow rates are required due to the sequence of operations as reported on the drawings or in Section 23 09 00 – Instrumentation and Control for HVAC, coordinate with these requirements and determine the required frequency - flow relationships
9. Verify that all terminal units are at the design cfm to within the balancing tolerance, and if not, repeat steps f. and g. above until design conditions are satisfied.

10. Test and record final motor, drive, air moving equipment, exhaust fan, damper, and terminal unit information at this point.
11. After all air flow rates are tested, adjusted, and balanced, test the performance of all air to air energy recovery equipment. Test the performance of air to air energy recovery equipment only when the outside air and inside air temperatures are close enough to summer or winter design conditions to verify performance. Test under either summer or winter conditions; if design conditions cannot be met during initial TAB work due to timing, provide energy recovery core testing under true design conditions at the six month system check. Include all data as specified above in reports.
12. Test and record air heating and cooling coil information after this point, as follows:
 - a. Perform this step in conjunction with hydronic system balancing and after cooling and heating systems are operational.
 - b. Set hydronic control valve to fully open at design flow and temperature as described below. Allow cooling coils to become fully wet with condensation. Test temperatures outside of the line of sight to the coil.
 - c. Test and adjust coil performance for all data indicated to be on report test sheets.

3.6 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 1. Measure total airflow.
 - a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
 2. Measure fan static pressures as follows to determine actual static pressure:
 - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
 - a. Report the cleanliness status of filters and the time static pressures are measured.

4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
 5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 6. Obtain approval from Architect, Construction, Manager Commissioning Authority for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 23 Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
1. Measure airflow of submain and branch ducts.
 - a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
 3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
- C. Measure air outlets and inlets without making adjustments.
1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.7 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
 - 1. Open all manual valves for maximum flow.
 - 2. Check liquid level in expansion tank.
 - 3. Check makeup water-station pressure gage for adequate pressure for highest vent.
 - 4. Check flow-control valves for specified sequence of operation, and set at indicated flow.
 - 5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
 - 6. Set system controls so automatic valves are wide open to heat exchangers.
 - 7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
 - 8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.8 PROCEDURES FOR HYDRONIC SYSTEMS

- A. Measure water flow at pumps:
 - 1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump at 60Hz/VSD bypass. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
 - a. If impeller sizes must be adjusted to achieve pump performance, obtain approval from Architect and comply with requirements in Division 23 Section "Hydronic Pumps."
 - 2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved and mark pump manufacturer's head-capacity curve with this initial balance point. Note and record pump discharge valve position, then return to wide open (or maximum non-overloading position) for proportional balancing procedure.

- a. Monitor motor performance during procedures and do not operate motors in overload conditions.
3. Verify pump-motor brake horsepower at intended flow rate at run-out. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
4. Report flow rates that are not within plus or minus 10 percent of design.
- B. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.
- C. With the system fully operational, all branch and terminal isolation, balancing, and control valves open, and the pump running at 60Hz/VSD bypass, measure the flow through all terminal units as well as the total system volume, without making any adjustments, and formulate a plan for preliminary balancing valve adjustment. Record and report all initial flow and pressure drop values.
- D. Adjust all manual balancing valves to the proportionally correct gpm, not necessarily the design gpm.
 1. If all the valves in a branch line's terminal units must be adjusted to limit gpm, then use the branch line manual balancing or isolation valve to limit the pressure drop across the terminal units in that branch so that at least one terminal unit's balancing valve remains wide open but still has the correct flow. Adjust all other branch lines to proper proportional gpm in this way, leaving the balancing valves in the flow limiting branches wide open.
 2. Provide branch volume control by balancing valves only to the extent that the most open valve remains wide open and adjustments do not create objectionable hydronic sound levels. Under no circumstances shall total system volume be throttled back to design flow through the partial closing of all branch valves.
 3. Record and report all initial adjustment positions and proportional flowrates achieved.
- E. Vary total system flowrate by adjustments at pump.
 1. For constant speed single pump operation systems: throttle the system pump balancing/triple-duty valve until the flow in the system is the design flow rate. If the available flow from the pump is less than the design flow using this procedure, report this to the engineer for advisement immediately. Report the pump, valve, and motor data both with the throttling valve in the wide open and at the final, design flowrate position.
 2. For variable frequency drive pumps, Perform the following procedure for each pump circuit running individually:
 - a. Ramp the VSD to the minimum frequency required to obtain the design flow, with each pump discharge valve open to the maximum position consistent with accurate reading and VSD bypass/60Hz non-overloading operation.

- b. Repeat this VSD adjustment for each pump circuit of lead / lag pumps driven by one VSD, and set the VSD at the higher of these two frequencies.
- c. At this frequency (the full design frequency - could be more or less than 60Hz), adjust the higher flow rate circuit to the design flow rate by further throttling the pump balancing valve, so that the flow rate from each pump is identical at the design frequency.
- d. Verify that all terminal units are at the design gpm to within the balancing tolerance, and if not, repeat steps above until design conditions are satisfied at all system valves, with no excessive pressure and resultant energy use.
- e. Report this value as the design frequency in the balancing report, and in writing to the Contractor responsible for incorporation into controls work of the Division 23 .
- f. Measure and report the flow-rate at 60Hz, and also at the frequency where the pump motor is running at full load amperage.
- g. Measure and report all other pump flow data at this point.
- h. Check settings and operation of each safety valve. Record settings.

3.9 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 - 1. Manufacturer's name, model number, and serial number.
 - 2. Motor horsepower rating.
 - 3. Motor rpm.
 - 4. Efficiency rating.
 - 5. Nameplate and measured voltage, each phase.
 - 6. Nameplate and measured amperage, each phase.
 - 7. Starter thermal-protection-element rating.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the automatic and manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.10 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record compressor data.
- D. Measure and record entering and leaving refrigerant pressures.

3.11 PROCEDURES FOR BOILERS

A. All Boilers:

1. Measure and record relief valve(s) pressure and setting.
2. Capacity: Calculate in Btu/h of heating output.
3. Fuel Consumption: If boiler fuel supply is equipped with flow meter, measure and record consumption.
4. Measure and record combustion air flow and temperature.
5. Measure and record flu gas temperature, flowrate, and combustion gas contents including % O₂, % CO₂, and ppm NO_x.
6. Efficiency: Calculate operating efficiency for comparison to submitted equipment.
7. Fan, motor, and motor controller operating data.

B. Hydronic Boilers:

1. Measure and record entering- and leaving-water temperatures and water flow.
2. Measure and record pressure drop.

3.12 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

B. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

3.13 PROCEDURES FOR EXHAUST HOODS

- #### A. Room Pressure: Measure and record room pressure with respect to atmosphere and adjacent space with hoods in room initially not operating and then with hoods operating.
- #### B. Makeup Air: Insure systems supplying source of makeup air to hoods are in operation during testing and balancing of exhaust hoods.

1. Measure and record temperature of makeup air entering hood. If hood makeup air is from multiple sources having different temperatures, measure and record the airflow and temperatures of each source and calculate the weighted average temperature.
 2. Use simulated smoke to observe supply air-distribution air patterns in vicinity of hoods. Consult with hood manufacturer and report conditions that have a detrimental effect on intended capture, containment, and other attributes effecting proper operation.
- C. Rooms with Multiple Hoods: Test each hood separately, one at a time, and repeat tests with all hoods intended to operate simultaneously by design.
- D. Canopy Hoods: Measure and record the following:
1. Pressure drop across hood.
 2. Airflow by duct traverse where duct distribution will allow accurate measurement, and calculate hood average face velocity.
 3. Measure velocity across hood face and calculate hood airflow.
 - a. Clearly indicate the direction of flow at each point of measurement.
 - b. Measure velocity across opening at multiple locations not exceeding 12 inch centers. Record velocity at each measurement, and calculate average velocity.
 4. Capture and Containment: Check each hood for proper capture and containment using a smoke-emitting device. Observe and report performance. Make adjustments to achieve optimum results.
- E. Kitchen Hoods:
1. Type 1: Measure and record pressure drop and face velocity of hood filters and slots in accordance with hood manufacturer's instructions. Consult hood manufacturer to determine hood airflow using recorded information.
 2. Type 2: Measure and record airflow by duct traverse.
 3. Capture and Containment: Check each hood for proper capture and containment using a smoke-emitting device. Utilize actual cooking or dishwashing equipment where possible. Observe and report performance. Make adjustments to achieve optimum results.
 4. Modulating Hood Controllers: Check each hood for proper automatic starting and capture under varying cooking load and smoke generated conditions up to full design cooking load.

3.14 PROCEDURE FOR MISCELLANEOUS DEVICE TESTING

- A. Test and adjust all devices on project as required to correctly report the data listed below under paragraph on final report.

3.15 TOLERANCES

- A. Adjust system totals to the sum of the connected load (plus leakage for air systems) rather than the scheduled pump or fan capacity.
- B. Adjust air handling systems as follows:
 - 1. Main ducts (ie. each fan system) to within minus 5 percent and plus 10 percent of the design values.
 - 2. Outside air flow tolerance shall be at minimum that scheduled, with a tolerance of minus 0 percent and plus 10 percent.
 - 3. Branch ducts and terminal units to within plus or minus 10 percent of the design flow.
 - 4. A total maximum variation of 10 percent between terminal units designated as “typical of (#)”.
- C. Adjust hydronic systems as follows:
 - 1. Each pump to within 5 percent of the design flow values.
 - 2. Branch lines and radiation to within 10 percent of the design flow values
 - 3. A total maximum variation of 10 percent between terminal units designated as “typical of (#)”

3.16 PRELIMINARY REPORTING

- A. Contract Document Examination Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for proper systems' balancing. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
- B. Pre-Construction Inspection and Testing Report: Prior to removal of any affected construction, prepare and submit report outlining results of Pre-Construction Inspection and Testing as outlined above and on the contract drawings.
- C. Status Reports: Prepare biweekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.17 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
 - 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 - 2. Include a list of instruments used for procedures, along with proof of calibration.

- B. Final Report Contents: In addition to certified field-report data, include the following:
1. Pump curves.
 2. Fan curves.
 3. Manufacturers' test data.
 4. Field test reports prepared by system and equipment installers.
 5. Other information relative to equipment performance; do not include Shop Drawings and product data.
- C. General Report Data: In addition to form titles and entries, include the following data:
1. Title page.
 2. Name and address of the TAB contractor.
 3. Project name.
 4. Project location.
 5. Architect's name and address.
 6. Engineer's name and address.
 7. Contractor's name and address.
 8. Report date.
 9. Signature of TAB supervisor who certifies the report.
 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 12. Nomenclature sheets for each item of equipment.
 13. Data for terminal units, including manufacturer's name, type, size, and fittings.
 14. Notes to explain why certain final data in the body of reports vary from indicated values.
 15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings including settings and percentage of maximum pitch diameter.

- f. Inlet vane settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.
 - h. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
 - 1. Quantities of outdoor, supply, return, and exhaust airflows.
 - 2. Water and steam flow rates.
 - 3. Duct, outlet, and inlet sizes.
 - 4. Pipe and valve sizes and locations.
 - 5. Terminal units.
 - 6. Balancing stations.
 - 7. Position of balancing devices.
- E. Air Moving Equipment (FCU, DOAS, RTU, MAU):
 - 1. Location
 - 2. Manufacturer
 - 3. Model
 - 4. Air flow, specified and actual
 - 5. Return air flow, specified and actual
 - 6. Outside air flow, specified and actual
 - 7. Total static pressure (total external), specified and actual
 - 8. Labeled diagram or annotated photograph showing pressure drop across each internal component including dampers, filters, coils, diffusers, and blowers. Provide multiple readings for complex systems with multiple internal dampers affecting system pressure drops, under all specified modes of operation. Include filter pressure drop under clean and partially loaded condition as specified.
 - 9. Inlet pressure
 - 10. Discharge pressure
 - 11. Applicable data as specified elsewhere including coil, motor, damper, and drive data.
 - 12. Fan RPM (for VSD driven fans, under various design conditions including at least full heating, 100% OA economizer, and full cooling loads)
 - 13. Sound Test Data
- F. Exhaust Fan Data (PRE, EF):
 - 1. Location
 - 2. Manufacturer

3. Model
4. Air flow, specified and actual
5. Total static pressure (total external), specified and actual
6. Inlet pressure
7. Discharge pressure
8. Fan motor and drive data
9. Fan RPM(for VSD driven fans, under various design conditions including at least full heating, 100% OA economizer, and full cooling loads).
10. Sound Test Data

G. Apparatus-Coil Test Reports:

1. Coil Data:
 - a. System identification.
 - b. Location.
 - c. Coil type.
 - d. Number of rows.
 - e. Fin spacing in fins per inch o.c.
 - f. Make and model number.
 - g. Face area in sq. ft.
 - h. Tube size in NPS.
 - i. Tube and fin materials.
 - j. Circuiting arrangement.
2. Test Data (Indicated and Actual Values):
 - a. Air flow rate in cfm.
 - b. Average face velocity in fpm.
 - c. Air pressure drop in inches wg.
 - d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
 - e. Return-air, wet- and dry-bulb temperatures in deg F.
 - f. Entering-air, wet- and dry-bulb temperatures in deg F.
 - g. Leaving-air, wet- and dry-bulb temperatures in deg F.
 - h. Water flow rate in gpm.
 - i. Water pressure differential in feet of head or psig.
 - j. Entering-water temperature in deg F.
 - k. Leaving-water temperature in deg F.
 - l. Refrigerant expansion valve and refrigerant types.
 - m. Refrigerant suction pressure in psig.
 - n. Refrigerant suction temperature in deg F.
 - o. Inlet steam pressure in psig.

H. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:
 - a. System and air-handling-unit identification.
 - b. Location and zone.
 - c. Room or riser served.

- d. Coil make and size.
 - e. Flowmeter type.
2. Test Data (Indicated and Actual Values):
- a. Air flow rate in cfm.
 - b. Entering-water temperature in deg F.
 - c. Leaving-water temperature in deg F.
 - d. Water pressure drop in feet of head or psig.
 - e. Entering-air temperature in deg F.
 - f. Leaving-air temperature in deg F.
- I. Gas Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
- 1. Kitchen Cooking Hood - MAU
 - 2. Unit Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Fuel type in input data.
 - g. Output capacity in Btu/h.
 - h. Ignition type.
 - i. Burner-control types.
 - j. Motor horsepower and rpm.
 - k. Motor volts, phase, and hertz.
 - l. Motor full-load amperage and service factor.
 - m. Sheave make, size in inches, and bore.
 - n. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - 3. Test Data (Indicated and Actual Values):
 - a. Total air flow rate in cfm.
 - b. Entering-air temperature in deg F.
 - c. Leaving-air temperature in deg F.
 - d. Air temperature differential in deg F.
 - e. Entering-air static pressure in inches wg.
 - f. Leaving-air static pressure in inches wg.
 - g. Air static-pressure differential in inches wg.
 - h. Low-fire fuel input in Btu/h.
 - i. High-fire fuel input in Btu/h.
 - j. Manifold pressure in psig.
 - k. High-temperature-limit setting in deg F.
 - l. Operating set point in Btu/h.
 - m. Motor voltage at each connection.
 - n. Motor amperage for each phase.
 - o. Heating value of fuel in Btu/h.
 - p. Sound Test Data.

J. Round, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:
 - a. System and air-handling-unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F.
 - d. Duct static pressure in inches wg .
 - e. Duct size in inches.
 - f. Duct area in sq. ft..
 - g. Indicated air flow rate in cfm.
 - h. Indicated velocity in fpm.
 - i. Actual air flow rate in cfm.
 - j. Actual average velocity in fpm.
 - k. Barometric pressure in psig.

K. Air-Terminal-Device Reports:

1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Apparatus used for test.
 - d. Area served.
 - e. Make.
 - f. Number from system diagram.
 - g. Type and model number.
 - h. Size.
 - i. Effective area in sq. ft..
2. Test Data (Indicated and Actual Values):
 - a. Air flow rate in cfm.
 - b. Air velocity in fpm.
 - c. Preliminary air flow rate as needed in cfm.
 - d. Preliminary velocity as needed in fpm.
 - e. Final air flow rate in cfm .
 - f. Final velocity in fpm.
 - g. Space temperature in deg F.
 - h. Sound Test Data.

L. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Service.
 - d. Make and size.

- e. Model number and serial number.
- f. Water flow rate in gpm.
- g. Water pressure differential in feet of head or psig.
- h. Required net positive suction head in feet of head or psig.
- i. Pump rpm.
- j. Design frequency for VSD pumps.
- k. Impeller diameter in inches.
- l. Motor make and frame size.
- m. Motor horsepower and rpm.
- n. Voltage at each connection.
- o. Starter size, rating, heater data.
- p. Amperage for each phase.
- q. Rated efficiency, full-load amperage, and service factor.
- r. Seal type.

2. Test Data (Indicated and Actual Values):

- a. Static head in feet of head or psig.
- b. Pump shutoff pressure in feet of head or psig.
- c. Actual impeller size in inches.
- d. Full-open flow rate in gpm.
- e. Full-open pressure in feet of head or psig.
- f. Final discharge pressure in feet of head or psig.
- g. Final suction pressure in feet of head or psig.
- h. Final total pressure in feet of head or psig.
- i. Final water flow rate in gpm.
- j. Voltage at each connection.
- k. Amperage for each phase.

M. Electric Motors:

- 1. Manufacturer
- 2. HP/BHP
- 3. Phase, voltage, amperage (nameplate, actual, and no load)
- 4. RPM
- 5. Service factor
- 6. Starter size, rating, heater elements

N. Automatic Air Dampers (AAD, TBAAD, or internal to air moving equipment):

- 1. Location
- 2. Manufacturer
- 3. Model
- 4. Airflow, specified and actual.
- 5. Check closed position leakage and report.

6. Damper and/or actuator position at all required positions, along with associated controls signal required to achieve position. Coordinate required positions of return air and outside air ventilation control dampers with positions required by required ventilation rates. Refer to SECTION 23 09 00 – INSTRUMENTATION AND CONTROLS FOR HVAC, and coordinate damper position adjustment with temperature controls and Owner's required occupancy schedule.
 7. Total static pressure drop at all required positions.
- O. Manual Air Volume Dampers (VD, or shown with no text as: 1):
1. Location.
 2. Report final damper position as angular deviation of blades from axial, with 0° being fully open and 90° being closed. Mark this position on duct at damper also.
 3. Total static pressure drop across damper in as balanced condition.
- P. Belt Drives:
1. Identification/location
 2. Required driven RPM
 3. Driven sheave, diameter and RPM
 4. Belt, model, type, size, and quantity
 5. Belt tension achieved.
 6. Motor sheave, diameter and RPM
 7. Alignment tolerances achieved.
 8. Center to center distance, maximum, minimum, and actual
- Q. Air Distribution Test Sheet (registers, grilles, and diffusers):
1. Air terminal number
 2. Room number/location
 3. Space Temperature
 4. Terminal type
 5. Terminal size
 6. Area factor
 7. Design velocity
 8. Design air flow
 9. Test (initial, adjusted, and final) velocities
 10. Test (initial, adjusted, and final) air flows
 11. Percent of design air flow
 12. Sound Test Data.
- R. Roof Top Hoods, Duct Entries, Goosenecks:
1. Air terminal number / drawing designation
 2. Room number/location
 3. Terminal type
 4. Terminal size
 5. Free Area
 6. Design velocity
 7. Test (final) velocity

8. Design air flow
9. Test (final) air flow
10. Percent of design air flow
11. Design Pressure drop
12. Test (final) pressure drop

S. Flow Measuring Station, Pump Discharge, and Balancing Valves:

1. Identification/station
2. Location
3. Size
4. Manufacturer
5. Model
6. Design flow rate
7. Design pressure drop
8. Actual/final pressure drop
9. Actual/final flow rate
10. Station calibrated setting

T. Automatic Balancing Valves Reports:

1. Identification/station
2. Location
3. Size
4. Manufacturer
5. Model
6. Design flow rate
7. Functional pressure drop range.
8. Actual/final pressure drop at system full flow condition.

U. Hydronic Control Valves Reports:

1. Location
2. Manufacturer
3. Model
4. Flowrate, specified and actual.
5. Pressure drop at full flow condition.

V. Gauges and Thermometers Reports:

1. Identification/number
2. Location
3. Service
4. Manufacturer
5. Test all gauges and thermometers for mid range accuracy. Adjust thermometers where applicable; adjust all gauges for best 0 and/or midrange accuracy.
6. Temperature, test reading and actual
7. Pressure, test reading and actual

W. Controls Sensors Reports:

1. Coordinate work with Energy Management and Control System.
2. Test all controls system temperature, pressure, air monitoring (CO₂, CO, combustible gasses, humidity, etc.), and electrical current analog sensors for mid normal operating range accuracy. Adjust where applicable.
3. Test all controls system temperature, pressure, air monitoring (CO₂, CO, combustible gasses, humidity, etc.), and electrical current digital (on/off) sensors/switches for trip point. Adjust where applicable.
4. Verify that locations shown on Operators Work Station are schematically correct.
5. Identification/number
6. Location
7. Service
8. Manufacturer
9. Temperature, test reading and actual
10. Pressure, test reading and actual
11. Air composition, parts per million, test reading and actual. Test and adjust at normal ambient and alarm conditions.

X. Instrument Calibration Reports:

1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.
 - e. Dates of calibration.

3.18 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
2. Check the following for each system:
 - a. Measure water flow of each device.

- b. Verify that balancing devices are marked with final balance position.
- c. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

1. After initial inspection by TAB Agency is complete and documentation verifies that testing and balancing are complete and accurately documented in the report, request that a final inspection be made, giving at minimum 7 calendar days' notice. Deliver copies of Draft Final Report to Engineer and Commissioning Authority with final inspection request.
 - a. Engineer may elect to postpone final inspection upon delivery of written notice to TAB Agency that significant portions of the required TAB results are missing from draft report. If inspection is postponed, TAB Agency shall promptly return to site and provide missing TAB Work, then submit a revised draft and request the Final Inspection again.
2. The TAB Agency and Contractor's qualified technicians are to provide access, tools, and measurements during the inspection in the presence of the TAB Agency Supervisor and the Commissioning Authority.
3. Commissioning Authority will randomly select measurements, documented in the report or as required by contract, to be rechecked. Rechecking will be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED." If recheck calls for a measurement that is required but cannot be found in the draft report, the missing measurement will be noted as "MISSING".
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the TAB Work will be considered defective and rejected. If the number of "MISSING" measurements is greater than 10 percent of the total measurements checked during the final inspection, the TAB Work will be considered defective and rejected.

C. If TAB Work is considered defective and rejected, proceed as follows:

1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection. Pay all costs associated with second inspection including Commissioning Authority's reasonable additional fees.
2. If the second final inspection also fails, Owner may require additional inspection similar to second inspection or may contract the services of another TAB agency to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB Agency's final payment.

D. Prepare test and inspection reports.

3.19 ADDITIONAL TESTS

A. Re-check and adjust systems approximately 6 months after final acceptance and submit report:

1. Measure the total flow rate of each of the systems originally covered by this section.
2. For each of the systems that no longer operate at design flow measure the flow at each of the terminals of that system.
3. Measure the flow at any terminals included in the original balancing, reported by the Owner or Architect to have continued or new problems.
4. Adjust system changes back to the design values if possible, and submit reports in writing to the Architect, Contractor, and Owner, noting any changes and/or complaints, and offering an interpretation of the cause and significance of the problems.
5. If the design air temperature criteria as specified cannot be satisfied upon initial balancing, perform this six month stability check at a time when it can be, and repeat water system balancing and chiller / heat exchanger performance testing using air temperature at the design conditions.

END OF SECTION 23 05 93

SECTION 23 07 00 – HVAC INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and all Division 01 Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes materials and installation requirements for mechanical component insulation and related accessories.

- 1. Insulation Materials:

- a. Cellular glass.
- b. Flexible elastomeric.
- c. Mineral fiber.
- d. Phenolic.
- e. Polyisocyanurate.
- f. Polystyrene.
- g. Fire rated insulation systems

- 2. Insulation Accessories:

- a. Insulating cements.
- b. Adhesives.
- c. Mastics.
- d. Lagging adhesives.
- e. Sealants.
- f. Factory-applied jackets.
- g. Field-applied fabric-reinforcing mesh.
- h. Field-applied cloths.
- i. Field-applied jackets.
- j. Tapes.
- k. Securements.
- l. Corner angles.
- m. Insulation protection systems

1.3 DEFINITIONS

- A. “Concealed”: Work within or behind various construction elements, or in crawl spaces or trenches, that is not exposed to view when Project has been completed. (Areas above ceilings, including above Auditorium or Large Group Instruction partially open “cloud” ceilings and chases are considered a concealed location.)
- B. “Exposed”: Anything exposed to view when project has been completed.

1.4 SUBMITTALS

- A. Comply with requirements of SECTION 01 33 00 – Submittal Procedures and as modified below.
- B. Provide all submittals required by this Section concurrently.
- C. Product Data
 - 1. Submit complete manufacturer's product information for each type of insulation and accessory specified in this section demonstrating compliance with specified requirements and including:
 - a. Thermal and vapor transmission performance.
 - b. MSDS information.
 - c. Flame spread / smoke developed data.
 - d. Manufacturer's recommended installation methods.
- D. Submit insulation schedule indicating each required service with type of insulation, thickness and R value, covering method, finishes, and any applicable notes.
- E. Quality Control Submittals
 - 1. Qualifications Certification: Submit written certification of installers signed by applicable certification agency and/or manufacturer (where applicable) indicating compliance with "Installer Qualifications" requirements specified below in "Quality Assurance" article.
 - 2. Installer Experience Listing: Submit list of completed projects using products proposed for this Project, including Owner contact information for each project, demonstrating compliance with applicable "Qualifications" requirements specified below in "Quality Assurance" article.
 - 3. Provide mock-ups for review and approval as described below.
- F. Contract Closeout Submittals: Comply with requirements of DIVISION 1 sections on closeout, including submission of maintenance instructions as item in "Operating and Maintenance Data" manual described there.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Provide insulation system installation by qualified Installers who are trained in installation of each proposed insulation material and product with at least one of the following qualifications:
 - 1. Have successfully completed a mechanical insulation apprenticeship program by the Department of Labor, Bureau of Apprenticeship and Training,
 - 2. Have successfully completed an ASHRAE / NIA 8 hour Mechanical Insulation Training course or equal, or

3. Have five years documented experience as a mechanical insulation specialist with references attesting to successful completion of at least three comparable projects.
- B. Condensation Resistance: Provide insulation and vapor barrier systems complete as required to eliminate condensation under any normal operating conditions from surfaces of all cooling equipment and components provided or modified as a part of this contract Work, unless those surfaces are designed to remove moisture by condensation from process air, and to contain and drain the condensate.
- C. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Components."
- B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate with installation and testing of heat tracing.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

1.8 DELIVERY, STORAGE AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. For convenience, details and specifications have been based on products by the following manufacturers:
1. Armstrong; Lancaster, Pennsylvania
 2. Benjamin Foster
 3. CertainTeed; Valley Forge, Pennsylvania
 4. Fit Tight Covers, Inc.
 5. Johns Manville; Defiance, Ohio
 6. Kingspan Tarec
 7. Knauf; North Carolina
 8. No Sweat Valve Wraps, Inc.
 9. Owens-Corning; Toledo, Ohio
 10. Polyguard Products Inc., Ennis, Texas
 11. Thermaxx, LLC.
 12. Or Approved Equal.

2.2 MATERIALS

- A. Pipe and Fitting Insulation: Provide pipe insulation in compliance with ASTM C 585 Dimensional Standards.

1. Insulation Thickness:

- a. Pipe and fitting insulation thicknesses specified assume an insulation conductivity (k) value of 0.27 btu•in/hr•ft²•°F. For pipe and fitting insulation with conductivity other than 0.27 btu•in/hr•ft²•°F, insulation must be thicker for higher conductivity and may be thinner for lower conductivity as required to achieve same or higher R value. Adjust insulation thickness from that specified in accordance with the following formula:

$$T = r[(1+t/r)K/k-1] \text{ where:}$$

- 1) T = Adjusted insulation thickness, inches
- 2) r = Actual pipe outside radius, inches.
- 3) t = Insulation thickness specified, inches.
- 4) K = actual insulation conductivity, btu•in/hr•ft²•°F.
- 5) k = specified conductivity, 0.27 btu•in/hr•ft²•°F.

b. Hydronic Piping for Heating:

- 1) Pipe sizes ½ inch through 1-¼ inches 1-1/2 inch
- 2) Pipe sizes 1-½ inches and larger 2 inches

- c. Make-Up Water and Condensate Drain Piping
 - 1) All pipe sizes..... ½ inch
 - d. Refrigerant Suction Piping:
 - 1) All pipe sizes..... 1 inch
 - e. All Variable Refrigerant Flow and Heat Pump Refrigerant Piping:
 - 1) All pipe sizes..... 1 inch
 - f. Flexible Connections:
 - 1) Pipe sizes ½ inch through 1-½ inches 1/2 inch
 - 2) Pipe sizes 2 inches and larger 1 inch
 - g. Runout piping in restricted spaces where it is not possible to provide the specified thickness may use reduced thickness insulation as required by space restriction.
2. Interior Above Grade Hydronic Piping Insulation:
- a. ASTM C547, cylindrically molded preformed rigid half pipe shell forms, factory one-piece “hinged” construction.
 - 1) Rigid pipe or tube insulation may be of mineral wool, fiberglass, closed cell glass, formed polyisocyanurate, formed phenolic, or extruded polystyrene (chilled service only).
 - 2) Thermal Conductivity (“k”): Measured in accordance with ASTM C 335. For k values greater than 0.27, include calculations and compliant increased thickness proposed. For k values equal or less than 0.27, provide specified insulation thickness or calculations justifying thinner insulation.
 - 3) Jacket: All Purpose (AP) vapor barrier jacket with:
 - a) White kraft paper outer surface bonded to aluminum foil, reinforced with fiberglass yarn, permanently treated for fire and smoke safety and to prevent corrosion of foil.
 - b) Self sealing pressure sensitive lap.
 - c) Water Vapor Permeance: ASTM E96, Procedure A, 0.02 perm maximum.
 - d) Puncture resistance: ASTM D781, 85 scale units minimum
 - e) Burst resistance: ASTM D774, 100psi minimum.
 - f) Similar to “150TL facing” as used in “AP T Plus Jacket” and tape by Johns Manville, or equal.
3. Exterior Above Grade Hydronic Piping Insulation:
- a. ASTM C547, cylindrically molded preformed rigid half pipe shell forms, factory one-piece “hinged” construction.

- 1) Rigid pipe or tube insulation may be of closed cell glass, formed polyisocyanurate, formed phenolic, or extruded polystyrene (chilled service only).
 - 2) Thermal Conductivity ("k"): Measured in accordance with ASTM C 335. For k values greater than 0.27, include calculations and compliant increased thickness proposed. For k values equal or less than 0.27, provide specified insulation thickness or calculations justifying thinner insulation.
 - 3) Exterior Pipe Insulation Protective Jacket specified below.
4. Refrigerant Piping, Flexible Connections Insulation: fire-resistant, closed cell flexible (elastomeric) foam plastic, similar to Armacell Armaflex with manufacturer's white painted mastic protective finish.
 5. Make-up water and Condensate Drain Lines: insulation material similar to rigid pipe or refrigerant piping insulation specified above.
 6. Fitting and Valve Insulation: Precut fiberglass blanket to match thickness, appearance and insulation value of adjacent pipe insulation; similar to "Hi Lo Temp Fiber Glass Insulation Insert" by Johns Manville, with fitted protective jacket specified for the installation.

B. Pipe and Fitting Protective Jackets:

1. Intended for permanent installation on non-serviceable components only.
2. Interior Pipe and Fitting Insulation Protective Jacket:
 - a. Plastic: High-impact, UV resistant polyvinyl chloride, white, paintable, covering designed to fit over AP jacketed insulated piping systems, molded to fit various sizes of fittings and piping as required; similar to "Zeston 2000 or Zeston 300 PVC Jacketing" by Johns Manville.
 - 1) 20 mil thickness: Fittings and valves in interior applications eight feet above finished floor and higher.
 - 2) 30 mil thickness: Fittings, valves, and straight pipe in interior applications lower than eight feet above finished floor.
 - b. Aluminum: Circumferentially corrugated 20mil thick or embossed 24 mil thick, with approved moisture barrier, with matching preformed fitting covers by same manufacturer. Similar to Corrolon by Childers.
3. Exterior Pipe and Fitting Insulation Protective Jacket: Modified bituminous, aluminum skinned, peel and stick membrane, similar to Polyguard "Alumaguard 60", with the following properties:
 - a. Minimum 60 mils thick
 - b. Permeance less than 0.01 perms
 - c. Puncture resistance per ASTM E154 >40lbs.
 - d. Overlap bond peel adhesion per ASTM D1000 never less than 11lb/in.

- e. UV stabilized.
- f. Self healing when punctured.

C. Valve Covers, Serviceable Hydronic Component Insulation Jackets:

1. 2" nominal size and smaller Strainers, Triple Duty, Autoflow Control, Manual Balancing, Check, Combination, and Control Valves, and other similar piping components needing periodic service, maintenance or adjustment - provide easily removable insulation jacket requiring no special tools for installation or removal / replacement:
 - a. Factory fabricated removable and reusable cover similar to products by No Sweat Valve Wraps, Inc., or approved equal.
 - b. Size so outer jacket overlaps adjoining sections of pipe insulation.
 - c. Flame and smoke spread 25/50 per ASTM E-84 or less.
 - d. Maximum k- factor .26 or matching surrounding insulation, using fiberglass blanket.
 - e. Outer jacket made of material equal to DuPont Tychem® QC (polyethylene coated Tyvek) , overlapping and completely covering the insulation with seams joined by integral elastic banding and tabs made from hook and loop fasteners (Velcro).
 - f. Butt ends and stem penetrations have sewn-in-place elastic. On cooling service, provide PSA backed closed cell foam gasket material adhered to stem penetration or surrounding insulation jacket between substrate and elastic jacket closure, as required insuring a complete vapor seal.
2. Pumps, Suction Diffusers, Triple Duty Valves, Balancing and Control Valves over 2" nominal size, and other HVAC components needing periodic service, maintenance or adjustment - provide easily removable, reusable insulation jacket in one of two types:
 - a. Fabric type insulation jacket similar to products by ThermaXX, LLC, Fit Tight Covers, or approved equal:
 - 1) Silicone impregnated fiberglass composite cloth jacketing, 17 oz/sq. yd. minimum, 5 lb/cf type E needled fiberglass mat insulation, 35 lb test Kevlar thread, fiberglass or nylon webbing, Velcro closures or high temperature FRP buckles.
 - 2) Constructed in a folded three-dimensional shape designed to minimize the air space and convection current in the space between the hot metal surface and the inner layer of insulation, seamed for removal and replacement inspection ease. Insulation sandwiched and protected between inner and outer layers of jacketing cloth.

- 3) All jacket pieces which match mating seams must include an extended 2" flap constructed from the exterior fabric (or equivalent) secured using hook & loop closure (i.e. Velcro®) and SS D-rings parallel to the seam or quick release adjustable buckles. Hog rings, staples, wire, etc., are not acceptable methods of closure.
- 4) Insulation sewn to inner and outer jackets to prevent shifting, in two layers minimum with staggered stitch lines between inside and outside jackets, of thickness as required to match R value of surrounding pipe insulation. All seams sewn with lock stitch at a minimum of 5 stitches per inch using specified thread. All seams except closing seam introverted, closing seam on inside: no raw cut jacket edges exposed after install.
- 5) For below ambient services, provide vapor barrier coated exterior jacket, with seam sealant at all stitch lines. Seal between jacket and equipment with replaceable closed cell gasket material to form a vapor barrier.
- 6) Provide a permanently attached Laser Etched Anodized Aluminum nameplate (2" x 3.5") on each jacket with the following information (or QR code and scanner app linking to information):
 - a) Item Number
 - b) Location Information
 - c) Application Type
 - d) Operating Pressure
 - e) Component Type
 - f) Component Size
 - g) Jacket Min Max Temp
 - h) Insulation Thickness
 - i) Jacket material Hot Side
 - j) Jacket material Cold Side
 - k) Pre Photo & Post Photos
 - l) Pattern

b. Metal box type field-fabricated insulation jacket:

- 1) Fabricate two piece removable metal boxes lined with insulation of thickness as specified.
- 2) Sheet metal box construction in accordance with section 23 31 00 – Ductwork and as follows.
- 3) Materials shall be G-90 galvaneal, painted to match surrounding insulation system color.
- 4) Secure enclosure to equipment with repeatedly re-usable bolts, clips, or bands that do not require tools for service access or additional tape for re-assembly.

- 5) Fabricate joints with hemmed edges, outward bolted flanges or secure latching mechanism. Bolt flanges on 6-inch centers, starting at corners, using 3/8-inch- diameter fasteners with wing nuts.
- 6) For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable closed cell foam gasket material to form a vapor barrier.

D. Duct Insulation

1. Provide insulation thickness on ducts, plenums, and equipment equal to height of flanges, but not less than thickness required to achieve duct insulation R values specified herein:
 - a. $R=6 \text{ deg. F-sq. ft.-h/Btu-in:}$
 - 1) All interior HVAC duct where insulation is required, unless otherwise noted elsewhere.
 - b. $R=12 \text{ deg. F-sq. ft.-h/Btu-in}$
 - 1) Interior outside air intake duct
 - c. $R=12 \text{ deg. F-sq. ft.-h/Btu-in:}$
 - 1) Exterior Duct with no transverse dimension above 48 inches ($R=10$ minimum, not average)
 - d. $R=20 \text{ deg. F-sq. ft.-h/Btu-in:}$
 - 1) Exterior Duct with any transverse dimension above 48 inches ($R=20$ minimum, not average)
 - e. Insulate to Special R values, as specifically noted elsewhere:
 - 1) Boiler breeching, high temperature duct, fire rated duct
2. Rigid Board: 3 PCF minimum density glass fiber board (6PCF when exposed in mechanical or utility spaces) or phenolic, with factory-applied AP vapor barrier; similar to “800 series Spin-Glas” and “AP” facing by Johns Manville, or Kingspan KoolDuct.
3. Semi-Flexible: 2.5 PCF minimum density continuous glass fiber oriented strand sheets, with factory-applied AP vapor barrier. Strand orientation such that material has comparable rigidity to board type insulation above in one direction and comparable compressive strength, but is flexible enough in the other direction to wrap curved surfaces at a factory recommended minimum bend radius of 3T where T is the material thickness. Similar to “CrimpWrap” by CertainTeed.
4. Flexible: Glass fiber blanket, 3/4 PCF minimum density, with factory-applied, flame-resistant, FSK jacket; all joints taped; similar to Owens Corning “Fiberglas All Service Duct Wrap”.

5. Acoustical / Thermal Duct Lining:
- a. Increase sheet metal size as required to provide free area shown on drawings
 - b. 1-inch thick minimum for sound lining or as otherwise noted. Where used together with external duct insulation, the combined R value must be at least that specified for the service. Where used in lieu of other thermal insulation, provide with rated R-value at least that specified for duct application.
 - 1) R6 duct service = 1.5 inches thick minimum
 - 2) R12 duct service = 3 inches thick minimum.
 - c. Maximum Thermal Conductivity: 0.24 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature (R value equals 4.2 per inch minimum).
 - d. Surface exposed to air stream and factory edges bonded then coated with a fire, bacterial, fungal and abrasion resistant coating; rated for velocities up to 4000 fpm.
 - e. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723 or ASTM E 84 as applicable, meets requirements of NFPA 90A; certified by an NRTL.
 - f. Materials:
 - 1) Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.
 - 2) Natural-Fiber Duct Liner: 85 percent cotton, 10 percent borate, and 5 percent polybinding fibers, treated with a microbial growth inhibitor and complying with NFPA 90A or NFPA 90B.
 - g. Liner Adhesive: As recommended by insulation manufacturer, low VOC, complying with NFPA 90A, NFPA 90B, and with ASTM C 916 as applicable.
6. High-Temperature Duct Insulation: Non-combustible glass fiber insulating wool, 2.4 PCF minimum density, bonded with thermosetting resin, suitable for temperatures up to 1000 deg. F minimum. Similar to Owens Corning "TIW Type II"
- a. Thickness: 1 inch and 2 inches as specified in Part 3 below.
7. Fire Rated Duct Insulation: U.L. 1978 listed, complying with requirements of ASTM E2336-04 for use in fire rated duct and grease duct assembly. Long ceramic or mineral fiber blanket, 6 PCF minimum density, 1-1/2 inch thickness unless otherwise specified. Cover with foil-faced scrim jacketing. Include all metal banding, collars, straps and U.L. listed tape and other accessories to make a complete listed assembly.

8. Exterior Duct Insulation: Rigid closed-cell extruded polystyrene or phenolic board with integral high density skin, foil or poly faced as recommended by insulation covering manufacturer, tongue and groove along long edges; complying with and exceeding requirements of ASTM C 578 for Type IV insulation, with the following properties:
 - a. Density: 1.6 pcf minimum.
 - b. Thermal resistance (R) at 75 deg. for 1-inch thickness: 5 nominal.
 - c. Compressive resistance at 10 percent deformation or yield: 25.0 psi minimum.
 - d. Tapered thickness as required to provide 1/4" to the foot slope for water shedding.
 - e. Flame spread (ASTM E84): less than 75.
 - f. Fuel contributed (ASTM E 84): less than 100.
 - g. UL listed.

E. Ductwork Insulation Protective Jackets:

1. All Purpose (AP) Vapor Barrier for Duct Insulation: White kraft paper outer surface bonded to aluminum foil and reinforced with fiberglass yarn, permanently treated for fire and smoke safety and to prevent corrosion of foil.
 - a. Water Vapor Permeance: ASTM E96, Procedure A, 0.02 perm maximum.
 - b. Puncture resistance: ASTM D781, 85 scale units minimum
 - c. Burst resistance: ASTM D774, 100psi minimum.
 - d. Similar to "150TL facing" as used in "AP T Plus Jacket" and tape by Johns Manville, or equal.
2. Foil-Skrim-Kraft (FSK) Vapor Barrier for Duct Insulation: Foil faced outer surface bonded to kraft paper backing and reinforced with fiberglass yarn, permanently treated for fire and smoke safety and to prevent corrosion of foil.
 - a. Water Vapor Permeance: ASTM E96, Procedure A, 0.02 perm maximum.
 - b. Similar to "FSK Jacket" and tape by Johns Manville, or equal.
3. Exterior Duct Insulation Covering:
 - a. Modified bituminous, aluminum skinned, peel and stick membrane, similar to Polyguard "Alumaguard 60", with the following properties:
 - 1) Minimum 60 mils thick
 - 2) Permeance less than 0.01 Perms
 - 3) Puncture resistance per ASTM E154 >40lbs.
 - 4) Overlap bond peel adhesion per ASTM D1000 never less than 11lb/in.
 - 5) UV stabilized.
 - 6) Self healing when punctured.
 - b. EPDM membrane as specified in Division 07 section 07 53 23 – EPDM Roofing.

F. Mechanical Equipment Insulation:

1. Thickness of insulation:

- a. Air Conditioning Service Diffusers: ½ inch (R=2 minimum)
- b. Heating Equipment:
 - 1) Pumps, air separators, suction diffusers: 2 inches (R=8 minimum).
 - 2) Hot storage tanks, heat exchangers: 3.5 inches (R=12.5 minimum).
- c. Cooling Equipment:
 - 1) Pumps, air separators, suction diffusers: 1-1/2 inches (R=6 minimum).
 - 2) Cold storage tanks, heat exchangers: 2 inches (R=8 minimum).

2. Air Conditioning Service Diffuser Insulation:

- a. Insulation: fire-resistant, closed cell flexible (elastomeric) foam plastic; similar to Armstrong "AP Armaflex". Provide sheet stock with either PSA backing or manufacturer's recommended adhesive – seal all joints with same adhesive.

3. Heating Equipment (Pumps, Suction Diffusers, Tanks, Air Separators, etc.):

- a. Insulation: Same as rigid board and semi-flexible duct insulation described above, in 6pcf density.
- b. Prefabricate assemblies so as to be easily removable in assembled sections for service.

G. Insulation Accessories:

- 1. Mechanical Pin Fasteners: Provide welded or adhered pins of length based on manufacturer's recommendations for insulation density and thickness, securely holding insulation with insulation manufacturer's recommended compression. Mechanical Pin Fastener types include:
 - a. Stud style welded pins minimum 12 gauge diameter with matching push-on washers. Welded on with capacitor discharge type pin welder with no burn through or undercutting. Welded on prior to insulation application allowing for inspection prior to insulating.
 - b. Cup head style welded minimum 12 gauge diameter with integral washers. Welded on with capacitor discharge type pin welder with no burn through or undercutting. Welded on after insulation application dis-allowing inspection of pin welds without insulation removal. Not permitted for any Class A or tighter duct, not permitted for any fire rated duct insulation application.
 - c. Adhered style with perforated metal back plate (minimum 4 square inches surface area) welded to 12 gauge pins with matching push washers, bonded with full coverage of manufacturer's recommended adhesive. Not permitted for any fire rated duct insulation application.

- d. Not permitted: PSA backed “peal and stick” pins, sheet metal fastening screws, or any other penetration of duct by fasteners.
- 2. Insulation Securement Bands: For larger cylindrical surfaces and fire rated duct insulation, tension securement bands may be used to supplement or replace mechanical pin fasteners. Provide bands of material compatible with insulation and system being insulated, minimum ½ inch wide and as required to avoid compressing insulation at required securement tension (¾ inch minimum for diameters over 36 inches), 24 gage thick or thicker. End buckles of similar material. Wrapping or securing with wires not permitted.
- 3. Insulation Covering Canvas: 8 oz., 100 percent cotton, with flame spread 10 and smoke developed 0 ratings; similar to “Thermocanvas” by Fattal, Chicago, Illinois.
- 4. Insulation Tapes: Provide insulation manufacturers’ recommended and matching tapes, matching characteristics of exterior jacket of insulation, in widths as required and as specified below to seal all gaps and reinforce vulnerable areas in vapor barrier. Provide tapes with peel off protective coating covering high performance acrylic adhesive unless manufacturer documents superior performance of alternative recommendation.
- 5. Insulation Adhesives and Mastics: Provide insulation manufacturers’ recommended and matching adhesives and mastics, as required and as specified below to seal all gaps and reinforce vulnerable areas in vapor barrier. Provide with water based and low VOC formulations unless manufacturer documents superior performance of alternative recommendation and performance deficiencies of water based low VOC products.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
- B. Verify that systems and equipment to be insulated have been tested and are free of defects.
- C. Verify that surfaces to be insulated are clean and dry.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.
- E. Beginning installation constitutes Contractor’s acceptance of substrates and conditions.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 INSTALLATION

A. General:

1. Provide thermal and acoustical insulation for components shown on the Drawings as specified in this Section for the following:
 - a. All heating and air conditioning systems piping including fittings, valves, and accessories.
 - b. All heating and air conditioning ductwork unless noted otherwise.
 - 1) All heating and air conditioning ductwork labeled as exposed shall not be insulated unless noted otherwise.
 - 2) All heating and air conditioning ductwork within a Mechanical Room, Boiler Room, Fan Room, etc., shall be insulated whether exposed or not.
 - c. All outside air ductwork extending from exterior wall or roof to the equipment which it serves.
 - d. Exhaust, return, and relief air ductwork not passing through air to air energy recovery devices prior to exiting the building: extending from exterior wall or roof 15 feet into the building envelope in all directions of duct branch take-offs.
 - e. Exhaust, return, and relief air ductwork that does pass through air to air energy recovery devices prior to exiting the system: insulate complete as described below.
 - f. Type 1 cooking exhaust hood ductwork outside of the space the hood is installed in: provide fire rated insulation with minimum two-hour F and T rating. Where hood exhaust exits building directly from space where hood is installed, insulate as required for exhaust duct as specified above.
 - g. Air separators, tanks, risers, and piping connections, and all other HVAC components that operate below, or more than 15 degrees F above ambient conditions.
 - h. All cooling condensate drain lines.
2. Comply with manufacturer's installation instructions and recommendations.
3. Do not begin mechanical insulation until permission is granted to begin mechanical insulation installation, hydronic systems have proved drip free under pressure, duct systems have passed required duct leakage requirements and testing, indoor work areas are weather tight, and outdoor work areas are at appropriate ambient conditions.
4. Below ambient temperature applications:
 - a. Provide corrosion inhibition coating as specified above.
 - b. Apply vapor barrier mastic and sealant to all open ends, joints, seams, breaks, and punctures in insulation.

5. Do not use any insulation support system which causes compression of insulation, localized or widespread, to less than 75% of the rated nominal thickness. Wires wrapped around rectangular duct insulation are not permitted as insulation support.
6. Provide for durable and repeated service access as part of insulation system.
 - a. Do not permanently cover inspection stampings, hand holes, manholes, plugged outlets, or similar features on equipment – provide removable labeled insulated access port with beveled and sealed insulation plug, gasketed if vapor barrier is needed, durably fabricated for repeated access.
 - b. Provide removable insulated boxes as specified for Pumps, Suction Diffusers, Heat Exchanger Frames and Heads, Triple Duty, Balancing, and Control valves, and other HVAC components needing periodic maintenance or adjustment.
7. Install thermal mechanical insulation as follows:
 - a. Only on clean, dry surfaces and after piping and ductwork has been tested and found to be tight.
 - b. Continuously through wall or ceiling openings and sleeves.
 - c. On cold surfaces with continuous unbroken vapor seal.
 - d. Insulate ducts and pipes individually.
8. Where more than one layer of insulation is required to achieve specified thickness or R value, apply thinner layer first, and stagger joints between insulation layers at least 3 inches.

B. Pipe Insulation

1. Comply with manufacturer's installation instructions and recommendations. Install only when ambient temperatures are within range recommended by manufacturer. STAPLES NOT PERMITTED.
2. Provide high impact plastic wrapper on all exposed, insulated piping from finished floor to 8 ft. above finished floor.
3. Interior Pipe and Fitting Insulation: Install on all heating, and condensate piping. Seal with factory applied pressure-sealing adhesive strip on the longitudinal lap. Seal butt joints with pressure-sealing adhesive strip at least 2 inches wide. Install valve and fitting covers in all locations.
4. Refrigerant Piping Insulation: Install in full accordance with manufacturers specifications and recommendations on refrigerant and condensate lines, using adhesive specifically intended for flexible foam plastic and provided by insulation supplier. Paint all exposed insulation cut ends with manufacturers (white) finish, similar to “WB Armaflex” or equal. Provide preformed elbows and fittings where available and neatly mitered and fit custom fabrications where manufactured components are not available. Tape and seal all joints vapor tight. For exterior refrigerant piping, install exterior piping protective wrapper water and air tight in accordance with manufacturer’s printed installation directions.

5. Insulation at Pipe Support: Refer to SECTION 23 05 29 - Hangers and Supports for material specifications of insulated piping support assembly and pipe support insulation. Complete insulation installation for the applicable pipe support insulation type to be used.
 - a. Type "B" Pipe Support Insulation:
 - 1) Install pipe support insulation at hanger and support locations in conformance with manufacturer's recommendations and as indicated on Drawings.
 - 2) Remove a section of insulation from pipe insulation and replace this section with heavy density molded fiberglass blocks without breaking vapor barrier wrap.
 - b. Type "C" Pipe Support Insulation:
 - 1) Provide butt connection to high-density insulation sections at pipe hangers as specified in Section 23 05 29 - Hangers and Supports.
 - 2) Provide insulation with vapor barrier on upper half of insulated piping support assembly.
 - 3) Apply wet coat of vapor barrier lap cement on butt joints and finish coat of vapor barrier mastic.
 - 4) Tape edge of insulation section edge and insulation with white, pressure-sensitive PVC tape with tape extending over adjacent pipe insulation by at least 2 inches.
- C. Ductwork Insulation: Provide external thermal insulation on ducts as specified or indicated on Drawings; external thermal insulation not required where ducts are shown or specified with internal acoustical insulation. Insulate and seal around duct dampers, damper motors, thermometers, instruments, access doors, and similar component as required without restricting operation or function. Insulate all ducts in all concealed spaces.
 1. Use flexible type insulation on concealed ductwork with widths or diameters of 18 inches or less only. Insulate all other ductwork requiring insulation with rigid board type, semi-flexible type, or other type as required by drawings and specifications.
 2. Duct Insulation Mechanical Fasteners: Provide mechanical fasteners for all duct surfaces over 12" wide. For duct surfaces 18" wide and less, provide single row of fasteners down duct centerline. For duct surfaces over 18" wide, install minimum of 2 rows per side, applied on maximum 18" centers, starting within 3" of any edge.
 - a. Pins with the point facing out accepting push washers: clip points close to washers and cover with vapor barrier adhesive and tape. Not permitted on mechanical room duct unless covered by puncture resistant protective wrapper.

3. Duct Insulation Tape: Apply only to clean dry dust free surfaces as recommended by tape manufacturer and as required for durable adhesion.
 - a. Peeling tape, loose insulation, or otherwise broken vapor barrier subject to repeated recall.
4. Rigid Board Type Insulation Installation: Install board with all corners mitered or rabbeted; no butt joints allowed. Secure insulation with mechanical fasteners. Apply corner reinforcement angles (beads) on all corners for exposed ductwork (including in mechanical or storage spaces), with edge tape over beads. Seal all breaks and joints in vapor barrier with 3 to 5 inches wide insulation tape (minimum 1.5" tape past break all around).
5. Semi-flexible Type: Install similar to rigid board type, on round duct, curved elbows, etc.. Wrap curved and round surfaces taught, provide circumference tape band maximum two feet on center (butt joints and center of four foot roll stock).
6. Flexible Type Insulation Installation: Make all joints and seams with 2-inch lap of vapor barrier cemented with Benjamin Foster "BF85-20". Apply Benjamin Foster "BF-20" adhesive to ducts in 6-inch brush widths at 1 ft. intervals and at each facing edge. Tape all adhered with Benjamin Foster "BF-20". Tape seal all seams, breaks, and joints in vapor barrier, then continuously coat all tape with manufacturer's recommended vapor barrier adhesive
7. Acoustical Duct Lining: Install on low velocity ductwork as noted on Drawings, adhering to sheet metal duct with 100 percent coverage of adhesive meeting the requirements of ASTM C 916, and additionally securing with mechanical fasteners as noted above but on 12-inch centers maximum in the transverse direction. Seal all edges, transverse joints and fastener penetrations with approved mastic. Protect all exposed edges with metal nosing causing no greater than 10% compression of the liner.
8. High Temperature Mechanical Insulation: Install all materials in strict compliance with manufacturer's printed instructions and recommendations where indicated on Drawings or recommended by manufacturer of specific equipment.
 - a. Install by attaching with welded pins or studs, spaced not more than 16 inches on center and not more than 4 inches from edge of insulation. Install 1-inch thick material first followed by 2-inch thick material. Offset all joints.
 - b. Cover with metal mesh and insulating cement. Recover with 7 oz. canvas, smoothly applied, adhered and sized with Benjamin Foster "BF-30" adhesive.
9. Fire Rated Duct Insulation: Install, precisely following manufacturer's instructions for banded securement, as required to achieve U.L. Listed fire rated assembly of the rating required by the application. If mechanical pin style insulation securement is required, (cup head pins or any adhered pins are not permitted), use stud style weld pins and inspect duct for weld penetrations of duct, pinhole leaks, cracked welds, etc., after stud welding and prior to insulating. No additional stud pin welding is permitted after duct inspection. If a no weld pin installation is permitted by the UL listed installation instructions, do not use weld pins.

10. Exterior Duct Work Insulation: Install insulation and covering in strict compliance with manufacturer's printed instructions and recommendations and as follows, and including exterior acoustically lined duct:
 - a. Mechanically fasten insulation to duct.
 - b. Slope top insulation a minimum ¼" per foot for positive drainage using tapered thickness panels, not shims with air gaps below.
 - c. Tape joints and ruptures in facing, using adhesive tape of type recommended by insulation manufacturer, and seal each continuous area of insulation to surrounding construction ensuring vapor tight installation.
 - d. Seal and protect exterior duct work insulation with Exterior Duct Insulation Covering, making all joints and terminations watertight with any and all special details as required by application.
 - e. Mechanically support bottom of duct Exterior Duct Insulation Covering on all exterior duct 24 inches wide and wider such that there is no unsupported dimension over 30 inches. Provide transverse and if required longitudinal strut system compressing Exterior Duct Insulation Covering against bottom of duct. Refer to Section 23 05 29 – Hangers and Supports for HVAC Components, for details of corrosion resistance and construction of insulation support system.
 - f. Provide for air pressure bleed ports in the bottom of insulation system of exterior positive pressure duct as required to bleed off duct leakage without pressurizing insulation system. Typical bleed port shall be similar to ¼" OD nylon tubing penetrating bottom of insulation full thickness of insulation, extending ½ inch below insulation cover, cut off at 45 degrees both ends, and sealed to insulation and covering with appropriate caulk. On vertical duct, slope down for drainage. Provide one bleed port for every 10 linear feet of exterior duct.
 - 1) Test and eliminate duct leakage before applying insulation system. If additional bleed ports are needed to prevent insulation covering from bulging out between supports due to internal pressure, remove insulation and reseal duct to control leakage.

D. Equipment, Tank, and Vessel Insulation Installation

1. Insulation Installation for Tanks and Vessels:
 - a. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
 - b. Develop three dimensional curves using cuts and curves, not wrinkles. Miter exterior corners and provide corner reinforcement angles. Do not use mastic or joint sealer as filler for gaps and voids resulting from poor workmanship: re-cut new better fitting pieces with adjacent insulation sections touching.
 - c. Protect exposed corners with secured corner angles.

- d. Secure insulation with adhesive, anchor pins and washers, and securement bands as required.
- e. Apply adhesives as follows:
 - 1) Select insulation adhesive compatible with service temperature, substrate, and insulation.
 - 2) Provide 100 percent coverage of tank and vessel surfaces.
 - 3) Follow manufacturers' recommended coverage rates per unit area.
- f. Install Mechanical Pin Fasteners on sides of tanks and vessels as follows:
 - 1) Do not weld anchor pins to ASME-labeled pressure vessels.
 - 2) Select insulation hangers and adhesive compatible with service temperature and substrate.
 - 3) Maximum pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
 - 4) Impale insulation over anchor pins and attach speed washers.
 - 5) In concealed applications, cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. In exposed mechanical room applications, bend excess portion of pins extending beyond speed washers parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
- g. Provide securement Bands as follows:
 - 1) Use where adhesives and mechanical pin fasteners are inappropriate or inadequate as required to secure insulation.
 - 2) Secure each layer of insulation with securement bands separately.
 - 3) Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.

2. Air Conditioning Service Diffusers:
 - a. Install insulation materials in accordance with manufacturers written instructions. Clean and dry diffuser backs before installation. Use one piece covering entire back of diffusers where possible, adhered durably vapor tight especially at edges, with smooth and even surfaces, and neat hole cut to fit duct collar. Seal to duct insulation.
3. Pumps, Suction Diffusers, Strainers, Triple Duty Valves, Balancing and Control Valves, and other HVAC components needing periodic maintenance or adjustment:
 - a. Provide removable covers as specified above.
 - b. Fit covers closely to component being insulated and adjacent system insulation and coincide joints with component and adjacent equipment installations allowing easy removal for service access to all parts requiring service.
 - c. Valves with insulated non-condensing stem assembly: insulate and seal to stem, leaving insulated adjustable portion of valve\’s exposed.
4. Surface Finish of Equipment Insulation:
 - a. Heating Equipment with no serviceable parts concealed: Reinforce insulation and cover with metal mesh and insulating cement. Recover with 8 oz. canvas, smoothly applied, adhered and sized with Benjamin Foster “BF-30” adhesive.
 - b. Cooling Equipment with no serviceable parts concealed: Glue all joints with 100% adhesive coverage of cut surfaces. Seal assembly vapor tight as required to avoid condensation. Paint all exposed insulation edges with manufacturers (white) finish, similar to “WB Armaflex” or equal, and cover all joints with manufacturer’s matching protective vapor barrier facing tape.

END OF SECTION 23 07 00

SECTION 23 08 00 - COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and other Division 01 Specification Sections, apply to this Section.
 - 1. See especially Section 01 08 00 "General Commissioning Requirements" for general commissioning process requirements and Commissioning Coordinator responsibilities.

1.2 SUMMARY

- A. Section includes commissioning process requirements for the following Building Mechanical Systems, which are described in more detail in the technical specifications of Division 23.
 - 1. Heat generation systems, including hot-water boilers, and auxiliary equipment.
 - 2. Cooling generation systems, including direct-expansion systems.
 - 3. Distribution systems, including supply and return air distribution (heating and cooling) systems, hot water distribution systems, exhaust systems air-handling units.
 - 4. Terminal and packaged units, including, unit heaters, fan-coil units, finned-tube radiation, and packaged units.
 - 5. Vibration, sound, and movement control systems, including vibration isolation devices, sound attenuation, and seismic restraints.
 - 6. Energy Management and Control System.
 - 7. Systems testing, adjusting, and balancing verification, including all of the above mentioned systems.

1.3 DEFINITIONS

- A. BAS: Building automation system, also known as Energy Management and Control System (EMCS).
- B. Building Mechanical Systems: All Systems, Subsystems, Equipment, and Components of the building systems traditionally known as Heating, Ventilating, Air Conditioning, Refrigeration, Plumbing, and Electrical Works.
- C. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
- D. CxA: Commissioning Authority –The Owner or a third party commissioning agent designated by the Owner.
- E. DDC: Direct digital controls, a part of the BAS.
- F. HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration.

- G. "Systems," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.
- H. TAB: Testing, adjusting, and balancing.

1.4 SUBMITTALS

- A. Qualification Data: For BAS and HVAC&R Testing Technician.
- B. Construction Checklists: Provide construction pre-functional test checklists filled out by qualified technician for all equipment to be commissioned on this project, including but not limited to all :
 - 1. Vibration, Sound, and Movement / Seismic controls for HVAC&R.
 - 2. BAS.
 - 3. Heating-water piping and accessories.
 - 4. Refrigerant piping.
 - 5. Metal ducts and accessories.
 - 6. Fans.
 - 7. Particulate air filtration.
 - 8. Air-handling units including DOAS and RTUs.
 - 9. Boilers.
 - 10. Heat Pump AC units
 - 11. Hydronic Pumps.
 - 12. Domestic Water Heating and delivery Systems.
- C. Certificates of readiness and completion of installation.
- D. Test and inspection reports and certificates.
- E. Corrective action documents.
- F. Instrumentation Calibration Information
- G. Functional Performance Test Procedures

1.5 QUALITY ASSURANCE

- A. BAS Testing Technician Qualifications: Technicians to perform BAS construction checklist verification tests, construction checklist verification test demonstrations, commissioning tests, and commissioning test demonstrations shall have the following minimum qualifications:
 - 1. Journey-level or equivalent skill level with knowledge of BAS, HVAC&R, electrical concepts, and building operations.
 - 2. Minimum three years' experience installing, servicing, and operating systems manufactured by approved manufacturer.
 - 3. International Society of Automation (ISA) Certified Control Systems Technician (CCST) Level I.

- B. HVAC&R Testing Technician Qualifications: Technicians to perform HVAC&R construction checklist verification tests, construction checklist verification test demonstrations, commissioning tests, and commissioning test demonstrations shall have the following minimum qualifications:
1. Journey-level or equivalent skill level. Vocational School four-year program graduate or an Associates degree in mechanical systems, air conditioning, or similar field. Degree may be offset by three years' experience in servicing mechanical systems in the HVAC industry. Generally, required knowledge includes HVAC&R systems, electrical concepts, building operations, and application and use of tools and instrumentation to measure performance of HVAC&R equipment, assemblies, and systems.
 2. Minimum three years' experience installing, servicing, and operating systems manufactured by approved manufacturer.
 3. One of the following:
 - a. National Environmental Balancing Bureau (NEBB) Certified Testing, Adjusting, and Balancing Technician.
 - b. Associated Air Balance Council (AABC) Certified Test and Balance Technician.
 - c. Owner retains the right to waive NEBB or AABC Certification.
- C. Testing Equipment and Instrumentation Quality and Calibration: For test equipment and instrumentation required to perform HVAC&R commissioning work, perform the following:
1. Submit test equipment and instrumentation list. For each equipment or instrument, identify the following:
 - a. Equipment/instrument identification number.
 - b. Planned commissioning application or use.
 - c. Manufacturer, make, model, and serial number.
 - d. Calibration history, including certificates from agencies that calibrate the equipment and instrumentation.
 2. Test equipment and instrumentation shall meet the following criteria:
 - a. Capable of testing and measuring performance within the specified acceptance criteria.
 - b. Be calibrated at the manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
 - c. Be maintained in good repair and operating condition throughout the duration of use on this Project.
 - d. Be recalibrated/repared if dropped or damaged in any way since last calibrated.
- D. Proprietary Test Instrumentation and Tools:
1. Equipment Manufacturer's Proprietary Instrumentation and Tools: For installed equipment included in the commissioning process, test instrumentation and tools manufactured or prescribed by equipment manufacturer to service, calibrate, adjust, repair, or otherwise work on its equipment or required as a condition of equipment warranty, perform the following:

- a. Submit proprietary instrumentation and tools list. For each instrument or tool, identify the following:
 - 1) Instrument or tool identification number.
 - 2) Equipment schedule designation of equipment for which the instrument or tool is required.
 - 3) Manufacturer, make, model, and serial number.
 - 4) Calibration history, including certificates from agencies that calibrate the instrument or tool, where appropriate.
- b. Include a separate list of proprietary test instrumentation and tools in the operation and maintenance manuals.
- c. HVAC&R proprietary test instrumentation and tools become the property of Owner at the time of Substantial Completion.

1.6 CONTRACTOR'S RESPONSIBILITIES

- A. Provide mechanical work in accordance with contract document requirements.
- B. Perform commissioning tests including Materials Checks, Installation Checks, Start-up Checks, Startups, and Functional Testing, all at the direction of the CxA.
- C. Attend construction phase controls coordination meetings.
- D. Attend and participate in TAB review and coordination meetings
- E. Attend and participate in commissioning meetings.
- F. Participate in Building Mechanical Systems maintenance orientation and inspection as directed by the CxA.
- G. Prepare Construction / Prefunctional Checklists and Functional Performance Test procedures and execute and document results. All Prefunctional Checklists and tests must be documented using specific, procedural forms in Microsoft Word or Excel software developed for that purpose. Prior to testing, Contractor shall submit those forms for review and approval.
- H. Submit documentation required for Commissioning work. At minimum, include: Detailed Start-up procedures, Full sequences of operation, Operating and Maintenance data, Performance data, checkout sheet forms used by factory or manufacturer's field technicians, Functional Performance Test Procedures, Control Drawings, and details of Owner-Contracted tests.
- I. Review and approve other relative documentation for impact on Functional Performance Tests of the systems:
 - 1. Shop Drawings and product submittal data related to systems or equipment to be commissioned. Review and incorporate comments from the CxA.
 - 2. Incorporate manufacturer's Start-up procedures with Prefunctional checklists.

3. Factory Performance Test Reports: Review and compile all factory performance data to assure that the data is complete prior to executing the Functional Performance Testing.
 4. Complete equipment Construction / Prefunctional Checklists, Start-up certification forms, and the manufacturer's field or factory performance and Start-up test documentation: review the documentation prior to commencing with the scheduled Functional Performance Tests.
 5. Final Testing Reports: Contractor or Subcontractor performing the test will review the documentation prior to commencing with the scheduled Functional Performance Tests.
 6. Operating and Maintenance (O&M) information per requirements of the Technical Specifications and Division 01 requirements: To validate adequacy and completeness of the Functional Performance Tests, the Contractor shall ensure that the O&M manual content, marked-up record Drawings and Specifications, component submittal drawings, and other pertinent documents are available at the Project Site for review.
- J. Provide information requested by the CxA for final commissioning documentation.
- K. Schedule work so that required installations are completed, and systems verification checks and functional performance tests can be carried out on schedule.
- L. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.
- M. Inspect, check and confirm in writing the proper installation and performance of all Work.
- N. Provide technicians to assist during system verification and functional performance testing as required by the CxA

1.7 CxA'S AUTHORITY

- A. Directing Commissioning.
- B. Assign Commissioning Agent for various commissioning tasks to stand in for the CxA.
- C. Edit and approve project-specific construction checklists and commissioning process test procedures for actual Building Mechanical Systems, assemblies, equipment, and components to be provided as part of the construction contract.
- D. Verify Testing, Adjusting, and Balancing of Work are complete.

1.8 COMMISSIONING DOCUMENTATION

- A. Provide the following information to the CxA for inclusion in the commissioning plan:
 1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.

2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for Building Mechanical Systems to be verified and tested.
4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
5. Certificate of readiness certifying that Building Mechanical Systems and associated controls are ready for testing.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TESTING PREPARATION

- A. Certify that Building Mechanical Systems have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify that Building Mechanical Systems instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
- C. Certify that Contractor portions of testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing report discrepancies have been corrected, and corrective work approved.
- D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- E. Inspect and verify the position of each device and interlock.
- F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- G. Testing Instrumentation: Provide (Furnish and Install) measuring instruments and logging devices to record test data as directed by the CxA.

3.2 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning tests at the direction of the CxA.

- B. Scope of Building Mechanical Systems testing includes entire HVAC&R installation. Testing includes measuring capacities and effectiveness of operational and control functions, accuracy and precision of sensing equipment, and other functional parameters as required, demonstrating that systems are performing as specified and intended. Commissioning testing includes verification of up to 30 percent of the control points, Testing and Balancing data, and other system requirements indicated in the individual technical sections, and on the drawings and schedules of these contract documents. Parameters not otherwise specified to be tested, as required to adequately demonstrate system performance, may constitute up to 10 percent of the 30 percent (3 percent of total).
- C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
- D. The CxA along with the Building Mechanical Systems Contractors and their Subcontractors, especially the Testing, Adjusting, and Balancing Subcontractor, and HVAC&R Instrumentation and Control Subcontractor, shall prepare detailed testing plans, procedures, and checklists for Building Mechanical Systems based on the actual installed equipment and the contract documents.
- E. Perform tests using design conditions whenever possible.
 - 1. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
 - 2. The CxA may direct that set points be altered when simulating conditions is not practical.
 - 3. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- F. If tests cannot be completed because of a deficiency outside the scope of the Building Mechanical System, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests. If deficiencies cannot be resolved, refine tests as required to adequately test Building Mechanical Systems within the constraints of the deficiency.
- G. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.3 TESTING, ADJUSTING, AND BALANCING (TAB) VERIFICATION

- A. Prior to performance of TAB Work, provide copies of approved sample report forms, checklists, and certificates to the CxA.
- B. Notify the CxA at least 10 days in advance of TAB Work, and provide access for the CxA to witness Testing, Adjusting, and Balancing Work.

- C. Subsequent to approval of formal TAB report, TAB Work will be subject to field verification. Provide technicians, instrumentation, and tools to verify testing and balancing of Building Mechanical Systems at the direction of the CxA. Roughly 10% of required TAB data points identified in TAB specification will be selected for subsequent field verification.
 - 1. The CxA will notify TAB Subcontractor 10 days in advance of the date of field verification. Notice will not include data points to be verified..
 - 2. The TAB Subcontractor shall use the same instruments (by model and serial number) that were used when original data were collected.
 - 3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.
 - 4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.4 SPECIFIC COMPONENT AND SYSTEM COMMISSIONING TESTS

A. Heat Generation Systems

- 1. Boiler Testing: Testing requirements are specified in Division 23 Section "Condensing Boilers", Paragraph 3.4.D. Performance Tests. Provide submittals, test data, inspector record, and boiler performance certification to the CxA.

B. Cooling Generation Systems

- 1. Refrigeration System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of refrigerant compressors and condensers, and other refrigeration systems. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested, as required demonstrating that any selected operating performance criteria are met or exceeded.

C. Air Distribution Systems

- 1. TAB Air Flow Verification:
 - a. Prerequisites: Completion of "Examination" Article requirements and correction of deficiencies, as specified in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
 - b. Completion of "Preparation" Article requirements for preparation of a TAB plan that includes strategies and step-by-step procedures, and system-readiness checks and reports, as specified in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
 - c. Scope: HVAC&R air systems and hydronic piping systems.

- d. Purpose: Differential flow relationships intended to maintain air pressurization differentials between the various areas of Project.
- e. Conditions of the Test:
 - 1) Commissioning Test Demonstration Sampling Rate: As specified in "Inspections" Article in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
 - 2) Systems operating in full heating mode with minimum outside-air volume.
 - 3) Systems operating in full cooling mode with minimum outside-air volume.
 - 4) For measurements at air-handling units with economizer controls; systems operating in economizer mode with 100 percent outside air.
- f. Acceptance Criteria:
 - 1) Under all conditions, rechecked measurements comply with "Inspections" Article in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC."
 - 2) Additionally, no rechecked measurement shall differ from measurements documented in the final report by more than two times the tolerances allowed.
 - 3) Under all conditions, where the Contract Documents indicate a differential in airflow between supply and exhaust and/or return in a space, the differential relationship shall be maintained.

D. General Hydronic System Testing

- 1. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in Division 23 piping Sections. HVAC&R Contractor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Plan shall include the following:
 - a. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.
 - b. Description of equipment for flushing operations.
 - c. Minimum flushing water velocity.
 - d. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.

E. Hot Water Distribution Systems

1. Heating-Water Supply Temperature Control:

- a. Prerequisites: Installation verification of the following:
 - 1) Startup of boiler.
 - 2) Startup of heating-water pump(s).
 - 3) TAB of heating-water flow and pressure.
 - 4) Input Device: Heating-water supply temperature sensors, thermometers, and thermostatic devices.
 - 5) Output Device: Control valve.
 - 6) Display the following at the operator's workstation:
 - a) Heating-water supply temperature.
 - b) Heating-water supply temperature set point.
 - c) Control-valve position.
- b. Scope: Heating-water system.
- c. Purpose: Control of heating-water supply temperature at input device.
- d. Conditions of the Test:
 - 1) Minimum heating-water flow.
 - 2) Midrange Heating-Water Flow: 50 to 60 percent of maximum.
 - 3) Maximum heating-water flow.
- e. Acceptance Criteria: Under all conditions, heating-water supply temperature is within plus or minus 2.0 deg F of set point.

2. Pump Testing and Acceptance Procedures: Testing requirements are specified in Division 23 Section "Testing, Adjusting, and Balancing for HVAC". Provide submittals, test data, inspector record, VSD setup reports, and pump alignment certification to the CxA. Pumps shall deliver the design flow rate and pressure using no more energy than as scheduled. Pump alignment shall be as specified. VSD setup and adjustment shall be as specified.

3. Control Primary Circulating Pump(s):

- a. Prerequisites: Installation verification of the following:
 - 1) Startup of heating-water pump(s).
 - 2) Input Device: Outdoor-air temperature; outdoor-air sensor.

- 3) Output Device: Heating-water pump; DDC system command to starter relay.
- 4) Display the following at the operator's workstation:
 - a) Outdoor-air temperature.
 - b) Operating status of primary circulating pump(s).
- b. Scope: Heating-water pump(s) and associated controls.
- c. Purpose: On-off control of heating-water pump(s) in response to variable outdoor-air temperature input; outdoor-air sensor.
- d. Conditions of the Test:
 - 1) High Temperature: Outdoor-air temperature above 65 deg F.
 - 2) Low Temperature: Outdoor-air temperature below 65 deg F.
- e. Acceptance Criteria:
 - 1) High Temperature: Pump(s) are off when outside-air temperature is above 65 deg F.
 - 2) Low Temperature: Pump(s) are on when outside-air temperature is below 65 deg F.

F. Air System Energy Recovery Systems

1. Energy Recovery Testing and Acceptance Procedures: Testing requirements are specified in Division 23 Section "Testing, Adjusting, and Balancing for HVAC". Provide submittals, test data, inspector record, and heat exchanger certification to the CxA. Heat exchanger shall exchange the energy flows scheduled with no greater pressure drop or approach temperatures than scheduled.

G. Exhaust Systems

1. Exhaust Fan Testing and Acceptance Procedures: Testing requirements are specified in Division 23 Section "Testing, Adjusting, and Balancing for HVAC". Provide submittals, test data, inspector record, and exhaust fan performance certification to the CxA. Exhaust fans shall be equipped with all accessories as specified and scheduled and shall be demonstrated to operate on the approved fan curve with no greater than the approved power requirements.

H. Air-Handling Units including DOAS and RTU's

1. Air-Handler Mixed-Air Control:
 - a. Prerequisites: Installation verification of the following:
 - 1) Minimum Position Input Device: DDC system time schedule.
 - 2) Output Device: DDC system analog output to modulating damper actuator(s).

- 3) Heating Reset Input Device: DDC system software.
- 4) Supply-Air Temperature Input Device: Electronic temperature sensor.
- 5) Display the following at the operator's workstation:
 - a) Mixed-air-temperature indication.
 - b) Mixed-air-temperature set point.
 - c) Mixed-air damper position.
- b. Scope: Air handler with mixed-air control and associated controls.
- c. Purpose:
 - 1) Occupied time control.
 - 2) Minimum damper position control.
 - 3) Heating reset control.
 - 4) Supply-air temperature control.
 - 5) Cooling reset control.
 - 6) Unoccupied time control.
- d. Conditions of the Test:
 - 1) Occupied Time Control: Start in unoccupied schedule. Advance to occupied schedule time.
 - 2) Minimum Damper Position Control: Command system to mode in which minimum damper position is required.
 - 3) Heating Reset Control: Create a call for heating.
 - 4) Supply-Air Temperature Control: Override supply-air temperature set point to a value 2.0 deg F above current supply-air temperature.
 - 5) Unoccupied Time Control: Advance to unoccupied schedule time.
 - 6) Control Data Trend Log: Set up a data trend log of the following input device values and output device commands. Record data at hourly intervals. Submit trend data for 24-hour periods in which natural conditions require heating reset control, supply-air temperature control, and economizer cooling control.
 - a) Minimum position input device.
 - b) Heating reset input device.
 - c) Supply-air temperature input device.
 - d) Cooling reset input device.
- e. Acceptance Criteria:
 - 1) Occupied Time Control: Mixed-air control is active in occupied mode.

- 2) Minimum Damper Position Control: Controller positions outdoor-air dampers to minimum position.
- 3) Heating Reset Control: Controller sets outdoor-air dampers to minimum position.
- 4) Supply-Air Temperature Control: Controller modulates outdoor-, return-, and relief-air dampers to maintain temporary supply-air temperature set point plus or minus 1.0 deg F.
- 5) Economizer Cooling Control: Controller sets outdoor-air dampers to maximum position when outdoor-air enthalpy is less than return-air enthalpy.
- 6) Unoccupied Time Control: Controller positions outdoor- and relief-air dampers closed and return-air dampers open.
- 7) Control Data Trend Log: Data verifies control according to sequence of control.

I. Unit Heaters

1. Unit Heater Testing and Acceptance Procedures: Testing requirements are specified in Division 23 Section "Testing, Adjusting, and Balancing for HVAC". Provide submittals, test data, inspector record, and Unit Heater performance certification to the CxA. Unit Heaters shall be equipped with all accessories as specified and scheduled and shall be demonstrated to deliver the scheduled airflow and heat capacity at no greater noise or power use levels than specified.

J. Fan-Coil Units

1. Fan-Coil Unit Testing and Acceptance Procedures: Testing requirements are specified in Division 23 Section "Testing, Adjusting, and Balancing for HVAC". Provide submittals, test data, inspector record, and Fan-Coil Unit performance certification to the CxA. Fan-Coil Unit shall be equipped with all accessories as specified and scheduled and shall be demonstrated to deliver the scheduled airflow and heat capacity at no greater noise or power use levels than specified.

K. Finned-Tube Radiation

1. Finned Tube Radiation (FTR) Testing and Acceptance Procedures: Testing requirements are specified in Division 23 Section "Testing, Adjusting, and Balancing for HVAC". Provide submittals, and test data certification to the CxA. FTR shall be installed level and plumb, neat and secure, with ready access to hydronic specialties as required for service, equipped with all accessories as specified and scheduled and shall be demonstrated to provide the specified and approved heating capacity while operating with no greater than the specified water flow.

L. Vibration, Sound, and Movement Control Systems

1. Coordinate Walk-through with CxA to verify installation is in accordance with specifications and submittals. Provide submittals, test data, inspector record, and Sound Attenuator performance certification to the CxA.

M. Energy Management and Control System

1. Testing requirements are specified in Division 23 Section “Instrumentation and Control for HVAC”, Section 3.11 SYSTEM TESTING AND COMMISSIONING. Provide submittals, test data, inspector record, and EMCS performance certification to the CxA.
2. Provide password and any other hardware and software as required to enable CxA to communicate directly, with full graphics and control capability, with the EMCS from the CxA’s office over an internet browser interface. Install complete early in project.

N. Electrical Power Distribution Systems Serving the Above Listed Mechanical (Plumbing and HVAC&R) Systems

1. Be prepared for CxA to take thermal images of field connections for any line voltage power connections.

END OF SECTION 23 08 00

SECTION 23 09 00 - INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.
- B. Review and study all drawings and this entire project specification to become familiar with the equipment and system operation as designed and to verify the quantities and types of controllers, valves, dampers, operators, alarms, points, etc., required.

1.2 SUMMARY

- A. This section describes the requirements for a complete Energy Management and Control System (EMCS) for building mechanical systems and components, based upon Direct Digital Control (DDC) logic including WEB served operator interface via the existing computer Operator Work Stations, distributed microprocessor controls, and integrated electronic components, interfaces, and actuation, all installed complete as specified.
- B. Perform all work in cooperation with the Owner, Architect, Construction Manager, and other Prime Contractors. Coordinate all work with the construction schedule established by the Owner, Architect, and Construction Manager, and immediately report any delays including circumstances causing the delays.
- C. It is the Owner's intent to establish a fully compatible and interoperable Energy Management and Control System (EMCS) network as an extension of the Arlington Central School District's distributed **Schneider Electric system by Stark Tech**. Accomplish this through the general removal of all existing controls components serving these systems, and providing new controls complete as specified herein. Provide new graphic displays for all new controls, and custom configure graphic displays to meet Owner and Engineer requirements. Provide each of the following portions of the complete EMCS as a standalone system that can communicate with any other Direct Digital Control (DDC) system which is following the same protocol:
 - 1. Operator Work Stations (OWS): Use existing system
 - 2. Network Control Unit (NCU): Provide central processor WEB server capability for and fully integrated two way communications with all energy use and management equipment provided or modified by this project, along with any third party stand alone controls provided by the manufacturers of the Air Handlers, Refrigeration Machinery, Boilers, and Variable Speed Drives. NCU shall be capable of supporting a minimum of 127 field devices, providing reserve capacity for addition of future points and expansion of DDC system into building. The DDC system's NCU shall communicate with the OWS entirely using the BACnet protocol, with a conformance class of 5, as defined in the latest officially amended version of ANSI/ASHRAE 135-2004.

3. Distributed Controls: System controls shall include but not be limited to all controllers, sensors, devices, wiring, and all other hardware and software required to perform all of the functions and controls described later in this specification and on the drawings, including fully integrated two-way control of boilers, chiller, condensing units, pumps, VSDs, heat exchanger, and all associated temperatures, pressures, and other controllable parameters of mechanical equipment and systems provided or modified as part of this project. Provide control through the EMCS as outlined in the general controls sequences of operations below, as shown on the project drawings, and with controls similar to as shown where the exact configuration is not explicitly covered by the drawing and specification sequence of operations.
4. Engineer's Office: Provide password and any other hardware and software as required to enable Engineer to communicate directly, with full graphics and control capability, with the EMCS from the Engineer's office over an internet browser interface. Install complete early in project. Engineer will utilize to check progress of installation, to check operation of system during the punch list period, and to monitor system operation after completion of the work.

1.3 DEFINITIONS

- A. DDC: Direct Digital Control.
- B. PC: Personal computer.
- C. EMCS: Energy Management and Control System, includes the complete automatic temperature control and energy use management system specified herein, based upon DDC technology, incorporating all necessary input and output devices, connecting hardware, software, and accessories.
- D. OWS: Operator Workstation which is the main operator interface with the EMCS, comprised of a PC with graphical two way interface with, and data base and control capabilities for, the entire EMCS.
- E. UC: Unitary Controller, a version of the SCU which is a smaller microprocessor-based controller, possibly pre-programmed to function specifically for the operation of a particular piece of equipment, such as a standard configuration air handler, unit ventilator, variable air volume box, lighting circuit, etc.
- F. SCU: Standalone Control Unit, a microprocessor-based controller panel, which contains all necessary control logic to carry out its own, local functions, and can function independently of other SCU panels and all remaining portions of the EMCS. The SCU may serve one or many types of HVAC equipment and is not factory programmed for only one purpose.
- G. NCU: Network Control Unit, a secure central processing unit microprocessor based WEB server residing directly on the Owner's Ethernet TCP/IP LAN/WAN; providing direct communications to SCUs, UCs, and other field devices; integrating and processing their data and presenting it as custom HTML WEB pages in accordance with custom programmed graphical interface edited at an OWS.

- H. LAN: Local Area Network - the Owner's existing Ethernet communications backbone which connects all of the owners buildings (and various rooms) on their campus. To be used by the Contractor where possible to connect OWSs, NCUs, SCUs, and UCs. Coordinate with Owner to determine extent of interconnection possible.
- I. BACnet: A Data Communication Protocol for Building Automation and Control networks as defined in American National Standard ANSI/ASHRAE 135-1995, including any updates or revisions to this document.
- J. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.
- K. MS/TP: Master slave/token passing.
- L. I/O: Input/output.
- M. Modbus: a serial communications protocol originally published by Modicon (now Schneider Electric) in 1979 for use with its programmable logic controllers (PLCs).
- N. PID: Proportional plus integral plus derivative.
- O. RTD: Resistance temperature detector.
- P. System Modem: a modem which is installed on the EMCS so that a remote SCU, UC, or OWS can connect up to the LAN and can function the same as if it were locally-installed.
- Q. System Printer: a printing device which is installed on the LAN so that all EMCS components can utilize it as an output device.
- R. TCC: Temperature Controls Contractor - The entity responsible for the work described by this section of specifications.

1.4 SYSTEM PERFORMANCE

- A. Comply with the following performance requirements:
 - 1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
 - 2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
 - 3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
 - 4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
 - 5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.

6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
 - a. Water Temperature: Plus or minus 1 deg F.
 - b. Water Flow: Plus or minus 5 percent of full scale.
 - c. Water Pressure: Plus or minus 2 percent of full scale.
 - d. Space Temperature: Plus or minus 1 deg F.
 - e. Ducted Air Temperature: Plus or minus 1 deg F.
 - f. Outside Air Temperature: Plus or minus 2 deg F.
 - g. Temperature Differential: Plus or minus 0.25 deg F.
 - h. Relative Humidity: Plus or minus 5 percent.
 - i. Airflow (Terminal): Plus or minus 10 percent of full scale.
 - j. Air Pressure (Space): Plus or minus 0.01-inch wg.
 - k. Electrical: Plus or minus 5 percent of reading.

1.5 QUALITY ASSURANCE

- A. Provide all labor, material, equipment, software, and programming necessary to meet the functional intent of the EMCS, and the rigid requirements as specified herein and as shown on the drawings. Provide, without additional cost to the Owner, all equipment and labor not specifically referred to herein or on the plans, which are required to meet the functional intent expressed in the sequences of operations herein or on the drawings. The contractor is responsible for all costs of changes in the work required by substitute equipment.
- B. The TCC must have been in business for at least ten years, providing DDC systems as their primary business with documented success. They shall have a minimum of five years as a manufacturer's authorized distributor or branch office representative for one or more of the manufacturers specified. They must have a trained staff of application engineers, project managers, software engineers, commissioning staff, training staff, and service staff experienced in the configuration, programming and service of the EMCS. They must have a local service department and stock the manufacturer's standard replacement parts.
- C. The EMCS shall be installed only by skilled mechanics employed directly by the TCC except wiring may be installed by their first tier subcontractor under the TCC project manager's direct supervision. Any subcontractor shall have documented success installing controls with the TCC for a minimum of five years prior to this project. Sub-contractual relations shall in no way relieve the contractor of any of their obligations under their contract.
- D. The TCC shall have a training facility with regularly scheduled training as outlined below so as to provide ongoing regularly scheduled application training.

- E. Manufacturer must be a firm regularly engaged in manufacture of microprocessor temperature control equipment, of configuration and capabilities similar to or better than specified equipment, for at least ten years, and must have similar earlier vintage models that have been in continuous satisfactory use for not less than ten years in similar service.
- F. All work shall conform to the following Codes and Standards, as applicable to the Contracted Work at the Project job site and to the relevant Authorities Having Jurisdiction at the Project site. All products shall be labeled with the appropriate approval markings. In the case of conflict or discrepancy, the latest and most stringent regulation or code shall apply.
 - 1. National Electrical Code (NEC) and applicable local Electrical Codes.
 - 2. Underwriters Laboratories (UL) listing and labels.
 - 3. Underwriters Laboratories of Canada (ULC) listing and labels.
 - 4. UL 864 UUKL Smoke Control.
 - 5. UL 864 UOJZ Fire Protection Signaling Systems.
 - 6. UL-873; Temperature Indication and Regulating Equipment.
 - 7. UL-916; Energy Management Systems for BAS components and ancillary equipment.
 - 8. NFPA 70 – National Electrical Code.
 - 9. NFPA 92A and 92B Smoke Purge/Control Equipment.
 - 10. Factory Mutual (FM).
 - 11. American National Standards Institute (ANSI).
 - 12. National Electric Manufacturer's Association (NEMA).
 - 13. American Society of Mechanical Engineers (ASME).
 - 14. Institute of Electrical and Electronic Engineers (IEEE).
 - 15. American Standard Code for Information Interchange (ASCII).
 - 16. Electronics Industries Association (EIA).
 - 17. Occupational Safety and Health Administration (OSHA).
 - 18. American Society for Testing and Materials (ASTM).
 - 19. Federal Communications Commission (FCC) including Part 15, R.F. Devices.
 - 20. Americans Disability Act (ADA).
 - 21. Uniform Building Code (UBC).
 - 22. NEMA 250 – Enclosures For Electrical Equipment (1,000 V Maximum).
 - 23. NFPA 101 – Life Safety Code.
 - 24. IESNA – Illumination Engineering Society of North America.
 - 25. UL 50 – Cabinets and Boxes.

1.6 GUARANTEES

- A. Guarantee the EMCS complete to be free from defects in durability, materials, and workmanship, except for damages from other causes, for a period of one year after final acceptance.
- B. Guarantee System to:
 - 1. Maintain temperatures within +/- 1°F of setting, within capacity of HVAC equipment.
- C. Provide a one (1) year maintenance agreement to run concurrently with the Guarantee period, consisting of 24 hour emergency service and scheduled service (once per month minimum), as required addressing reported issues, for inspection and adjustment of operating controls, and replacement of parts or instruments found deficient or defective during this period.

- D. Provide system backup and restore, software, programming, and sequence of operations enhancements, revisions, and adjustments at no charge to the Owner both during construction and commissioning and during this warrantee period.

1.7 SEQUENCE OF OPERATION

- A. Refer to controls schematic drawings including written sequence of operations for specific pieces of equipment. Provide controls as specified and as required to achieve sequence of operations shown on drawings as well as specified below in general programming, and with controls similar to as shown where the exact configuration is not explicitly covered by the drawing and specification sequence of operations.

1.8 SUBMITTALS

- A. Submit on controls in multiple portions as job progresses. Include in each submittal a summary just inside the cover sheet of previously approved portions of submittal, currently submitted portions, and those portions not submitted yet. During closeout documentation, assemble all approved controls submittals into one package designed for use as both an installation and a maintenance manual.
- B. Submit a Technical Proposal within 30 days of contract award or earlier as required for expedited construction schedule, complete with the diagrams, Specification Compliance Reports, product information, and supporting documentation outlined below. Arrange the Technical Proposal in order of the specification article numbers, with tabs (bookmarked .pdf files for electronic submittals) at each division. The Technical Proposal shall be designed for use as both a clear demonstration of qualifications and as an installation and maintenance manual. Progress submittals specified under paragraph 1.8.D below will not be reviewed prior to approval of the Technical Proposal submittal. Do not begin any demolition or new controls work prior to approval of the Technical Proposal.
- C. Include the following in a complete Technical Proposal:
 - 1. Description of service capabilities including resumes for service technicians and designers that will be responsible for this project.
 - 2. A list of local jobs (three minimum) of similar type and size the bidder has installed, utilizing the products proposed for this project, with Owner's representatives and engineer of record's names and telephone numbers for reference. This list should directly reflect:
 - a. Projects that include direct integration to third party microprocessor controllers of the type specified within this scope.
 - b. For all proposed TCCs other than the specified basis of design, include projects with successful complete two-way communication and integration or replacement of the basis of design EMCS, including full transparent control and programming capability from the single workstation.

3. Submit name of any proposed installation subcontractors, along with their statement of qualifications, resumes for service technicians who will be responsible for this project, and 3 local references for comparable recent jobs.
4. EMCS network wiring diagram showing interconnection of all existing and new panels, workstations, system printer(s) etc., describing system architecture for this project with product code numbers for workstation, network controllers, application specific controllers, transducers, sensors, communication networks, etc.. Include all components intended to be used to meet or exceed specification requirements, shown in their functional relation to one another. Obtain from Owner and include the current EMCS system architecture diagram and complete existing control point list prior to any demolition and demonstrate intent to integrate all current control points into the EMCS work.
5. Provide information on owner training provided as part of the bid package as well as additional opportunities and factory schools available with associated costs. Include details of Operator HVAC Training System as specified herein.
6. Specification Compliance Report. The specification compliance report shall address every paragraph within this specification (230900), utilizing an outline format indicating clearly how the proposed system complies with this specification as follows:
 - a. No Exception - proposed system complies without exception to both the letter and intent of this specification. Include Data Communications Protocol Certificates certifying that each proposed DDC system component complies with ASHRAE 135.
 - b. Substitution Exception - proposed system is believed to meet the functional intent, but not the letter of the specification. For each paragraph for which a Substitution Exception is taken, the Specification Compliance Report shall identify all deviations from what is specified in the given paragraph and provide a complete description of what is included and how the proposed substitution meets the functional intent.
 - c. Non-Compliance Exception - proposed system does not meet specification letter or functional intent, and the contractors intent is that the paragraphs requirements will not be provided. For each paragraph for which a Non-Compliance Exception is taken, the Specification Compliance Report shall identify all deviations from what is specified in the given paragraph and provide a complete description of what is included and why the contractor believes their proposed system should still be considered in spite of the non-compliance
 - d. For all paragraphs indicated as “No Exception” or “Substitution Exception”, provide and reference factory product documentation to substantiate compliance.
7. Hardware Product Data Bulletins for all specified products, including PC components of OWS. Each bulletin shall describe product features, model numbers and manufacturer’s name.
8. Software Product Data Bulletins for all specified software features. Each bulletin shall describe product features, model numbers, and manufacturer’s name.

- D. As job progresses and in ample time for review and iteration as required for complete approval, submit the following:
1. Complete written description of all proposed control sequences and control strategy, with any deviations from the specified sequence of operations highlighted and explained.
 2. Detailed wiring and piping control diagrams and system description for each system.
 3. Detailed layout and nameplate list for all control panels, including pneumatic, unit-specific controllers, data-gathering panels, microprocessor-based panels, third party microprocessor controllers, etc.
 4. Damper schedule giving size, type, velocity, pressure drop, configuration, location, and number, type, and size of motorized actuators. Include apparatus bulletins and data sheets. Include all existing to remain dampers proposed for reuse along with comments on condition.
 5. Valve schedule giving valve identification tag abbreviation, location, service, failsafe position, pipe size, valve size, make/model, type, configuration, design flow, capacity index (cv), and pressure drop. Include apparatus bulletins and data sheets.
 6. Schedule showing direct integration to all third party microprocessor controllers included in this project, including all points available in a point listing describing point type (analog input, binary input, analog output and binary output), point address, units, applicable software interlocks (alarm, interlock, sequence, etc.), and a verbal description of the function and intended control of the point.
 7. Termination schedule and point listing describing point type, (analog input, binary input, analog output and binary output), physical point location (eg. AHU #1 mixed air) and software interlocks (alarm, interlock, sequence, etc.).
 8. A complete listing of inputs and outputs, control loops and/or routines, timing functions, and facilities management system functions for each controlled system. This listing shall include point logical names and identifiers.
 9. For all equipment, submit copy of written installation, maintenance, and operating directions and details, along with manufacturer's printed installation instructions for all equipment furnished, showing required installation and location of the above items.
 10. Provide a sample of program language and description of how programming is accomplished.
 11. Color printout sheets of representative samples of all proposed graphics and text based OWS pages.
- E. Software and Firmware Operational Documentation: Include the following:
1. Software operating and upgrade manuals.
 2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
 3. Device address list.

4. Printout of software application and graphic screens.
 5. Software license required by and installed for DDC workstations and control systems.
- F. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.
- G. Field quality-control test reports.
- H. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
 2. Interconnection wiring diagrams with identified and numbered system components and devices.
 3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
 4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
 5. Calibration records and list of set points.

1.9 RELATED AND ANCILLARY WORK

- A. Electrical control wiring associated with building fire alarm system and duct smoke detectors: Installation is specified under Division 26.
- B. Power source wiring for general (non-controls) HVAC motorized equipment: Installation specified under Division 26.
- C. Provide power source and controls wiring for all EMCS equipment, complete back to breakers designated as temperature control power breakers on electrical drawings or other approved electrical power panel space. Includes all controls power source wiring, communication wiring, and actuated device power and control wiring. Installation specified both herein and in applicable sections of Division 26.
- D. Piping work as required to maintain pressure tight integrity of all hydronic, potable water, and refrigerant based systems for the installation of all piping mounted controls components, including control valve installation, valve and control manifolds, pressure and temperature taps, flow switches, thermal wells, and similar devices: Installation specified both herein and under applicable piping section.
- E. Sheet metal work as required to maintain pressure tight integrity of all airside systems for the installation of all airside mounted controls components, including dampers, pressure and temperature probe taps, flow sensors, and similar devices: Installation specified both herein and under applicable sheet metal and ductwork sections.
- F. Insulation work as required to maintain the thermal integrity of the various systems associated with and subsequent to controls component installations: Installation specified in Division 23 section on Insulation.

- G. For all equipment: Provide and follow written installation directions and details, with manufacturer's printed installation instructions for all equipment furnished, showing required installation and location of the above items.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for submittal, approval, fabrication, and shipping of control devices to equipment manufacturer in ample time for factory installation without impacting project schedule.
- B. System Software: Update to latest version of software at Project completion.

1.11 INSTRUCTION AND TRAINING

- A. Factory Authorized Control System Training:
 - 1. Provide factory trained and authorized instructors and control technicians to instruct the Owner's operating personnel.
 - 2. Factory authorized on site training - Provide two (2) on site training sessions each four (4) hours in duration covering network layout, controllers, and software functions. Both generic and product specific training shall be provided. Sessions shall be scheduled by the Contractor at the Owner's convenience, at any time up to two years after system installation.
 - 3. Factory authorized on site training - Provide six (6) on site training sessions each four (4) hours in duration covering network layout, controllers, and software functions. Both generic and product specific training shall be provided. Sessions shall be scheduled by the Contractor at the Owner's convenience, at any time up to two years after system installation.
 - 4. Factory authorized off site training - Provide three (3) day factory authorized off site training course for up to two Owner's representatives, covering advanced topics related to their EMCS, including graphics modification and creation, control software programming, system communications, remote communications, database management, and trouble shooting. Include all incidental expenses.
 - 5. Provide videotaping and audio taping of all training sessions, both off and on site. Turn over two copies of tapes and three copies of maintenance manual to Owner's representative.
- B. Include in closeout documentation signed letter of acknowledgment of receipt of factory authorized training, videotapes, and maintenance manuals.

1.12 COORDINATION

- A. Coordinate all controls work required for a complete operable controls system as specified. Carefully review project summary and scoping documentation and coordinate with contractors responsible for various ancillary portions of controls work. Where supportive or ancillary work is not specifically assigned to another contractor, provide complete as required for a complete operable system.
- B. Coordinate equipment with Division 28 Sections on Fire Detection and Alarm Systems to achieve compatibility with equipment that interfaces with that system.
- C. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.
- D. Coordinate equipment with Division 26 Sections on Electrical Power Monitoring and Control to achieve compatibility of communication interfaces.
- E. Coordinate equipment with Division 26 Sections on Panelboards to achieve compatibility with starter coils and annunciation devices.
- F. Coordinate equipment with Division 26 Sections on Motor Controls to achieve compatibility with motor starters and annunciation devices.
- G. Coordinate size and location of concrete bases. Refer to Section 23 05 00 – COMMON WORK RESULTS FOR HVAC SYSTEMS for additional information.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Temperature Control Sub-Contractors (TCCs): Existing district wide web based Energy Management and Control System (EMCS) and Basis of Design Energy Management and Control System (EMCS) is,
 - 1. Schneider Electric by Stark Tech
 - 2. The District's intent to purchase the labor and material from "State Bid Contract".

2.2 GENERAL SYSTEM ARCHITECTURE

- A. The EMCS shall consist of the following:
 - 1. Operators' Workstations (OWS).
 - 2. File Server (FS).
 - 3. Network Control Units (NCU).
 - 4. Standalone Control Units (SCU).

5. Application Specific Unitary Controllers (UC).
 6. All controls power wiring 120 volts or less, all network and communication wiring, fiber optic cable, and other controls communication media.
 7. All EMCS communications devices.
 8. All related field devices including remote I/O cabinets, transformers and power supplies, relays, contactors, transducers, switches, cabling, and related electronic control equipment.
 9. All necessary software and custom programming, including graphics and reports.
 10. All necessary inputs, outputs, and devices required to meet the features and intent described herein including but not limited to:
 - a. Transducers.
 - b. Water flow switches and sensors.
 - c. Differential Pressure sensors.
 - d. Hydronic control valves.
 - e. Opposed blade (control) or parallel blade (shutoff), low leakage dampers.
 - f. Temperature, pressure, and humidity sensors and safety devices.
 - g. Electronic valve and damper actuators.
 11. All other equipment necessary for a complete, operational, EMCS.
- B. The design of the EMCS shall network OWSs, FCs, NCUs, SCUs, UCs, and all sensors, safeties, actuators, and other devices. Inherent in the system's design shall be the ability to expand or modify the network via the Internet, the Level 1 LAN, the Level 2 bus, or via auto e-mail or auto-dial telephone line modem connections, or via a combination of all four networking schemes. LAN communications between buildings shall be standard ETHERNET TCP/IP and shall be compatible with the district's existing ETHERNET LAN.
- C. The EMCS shall:
1. Be modular in nature, with distributed controllers operating in multi-user, multi-tasking environment on token-passing network.
 2. Be re-programmable and programmed to control mechanical, electrical, and plumbing systems.
 3. Be capable of integrating multiple building functions, equipment supervision and control, alarm management, energy management, historical data collection, and archiving.
 4. Permit expansion of both capacity and functionally through the addition of components and programming.
 5. Include an operator workstation which permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.

6. Not be dependent upon any single device for alarm reporting and control execution. Each DDC panel shall operate independently by performing its own specified control, alarm management, operator I/O, and historical data collection. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

D. The system architecture shall consist of no more than two communication levels as follows:

1. Level 1 shall be on the Owner's ETHERNET LAN as possible within the constraints of this specification. Contractor shall field verify extent and capacity of existing LAN with Owner prior to creation of network layout drawings, and shall include any and all extensions of the LAN required for complete and robust functioning of the EMCS:
 - a. Level 1 communications shall use the BACnet protocol.
 - b. This LAN operates under ETHERNET protocol at 10 Mbps or other speed as determined by the Owner. The Level 1 LAN will provide transfer of point data, alarms and file activity among OWSs, NCUs, and SCUs.
 - c. Any data from a Level 2 controller can also be transmitted onto this bus through a Level 1 controller. The high speed LAN shall support multi-user communications and multi-session activity. That is, all global data sharing shall occur simultaneously with the transmission of alarm data or user activity.
 - d. OWSs and NCUs shall reside directly on the LAN such that communications may be executed directly between controllers, directly between workstations, and between controllers and workstations, on a peer-to-peer basis.
 - e. SCUs and UCs may reside directly on the Level 1 Lan at the TCCs option.
2. Level 2 shall be on a EIA-485 bus or other comparable technology, designed to support a family of dedicated local controllers for control of HVAC equipment and lighting. The Level 2 bus shall communicate bi-directionally with the Level 1 LAN through NCU controllers for transmission of global data:
 - a. The Level 2 bus, or field bus, shall support local control units (SCUs and UCs) of modular size for operation of the building's HVAC and lighting systems. This bus shall operate at a minimum speed of 200 kbps with a length of 4000 feet and 10Mbps with a length of 150 feet, with 32 nodes before requiring a network repeater. A minimum of 127 controllers shall be configurable on the field bus.
 - b. The field bus shall permit peer-to-peer communications among all Level 2 controllers and allow simultaneous communications with portable computer service tools that are connected to a Level 2 controller. Failure of any Level 1 NCU controller shall not impair the operation of its associated field bus.
 - c. All Level 2 field wiring that connects non native BACnet unitary controllers shall have an additional wiring set run in parallel dedicated for future use by native BACnet replacement controllers.

- E. NCUs shall be able to access any data from, or send control commands and alarm reports directly to any other NCU or combination of NCUs on the network without dependence upon a central processing device. NCUs shall also be able to send alarm reports to multiple operator workstations without dependence upon a central processing device.
- F. Dynamic Data Access:
1. All operator devices, network resident, internet connected, or connected via dial-up modems, shall have the ability to access all point status and application report data, or execute control functions for any and all other devices via the LAN. Access to data shall be based upon logical identification of building equipment.
 2. Access to system data shall not be restricted by the hardware configuration of the EMCS. The hardware configuration of the EMCS network shall be totally transparent to the user when accessing data or developing control programs.
 3. All points contained on Level 1 and Level 2 controllers shall be considered global points. Any program in any controller on the network shall be able to reference any point in any controller regardless of its location on the network.
- G. General Network Design:
1. Network design shall include the following provisions:
 - a. Data transfer rate for alarm reporting, report generation from multiple controllers, and upload/download between SCUs and OWSs shall be a minimum of 2.5 Megabaud.
 - b. Support of any combination of controllers and operator workstations directly connected to the local area network. A minimum of 50 devices shall be supported on a single local area network.
 - c. Detection and accommodation of single or multiple failures of either OWSs, SCUs, or the network media. The network shall include provisions for automatically reconfiguring itself to allow all operational equipment to perform their designated functions as effectively as possible in the event of single or multiple failures.
 - d. Message and alarm buffering to prevent information from being lost.
 - e. Error detection, correction, and re-transmission to guarantee data integrity.
 - f. Default device definition to prevent loss of alarms or data, and ensure alarms are reported as quickly as possible in the event an operator device does not respond.
 - g. Commonly available, multiple sourced, networking components and Ethernet protocols shall be used to allow the EMCS to coexist with other networking applications on the Owner's existing LAN/WAN. Ethernet and BACnet are acceptable technologies. BACnet system shall conform to the latest ASHRAE Standards and recommendations.

- h. Use of an industry standard IEEE 802.x protocol.
- i. Provide synchronization of the real-time clocks in all EMCS panels.

2.3 NETWORK CONTROL UNITS (NCUs)

- A. General: Network Control Units shall be microprocessor based, multi-tasking, multi-user, and employ a real time operating system. Each NCU control panel shall consist of modular hardware including power supply, CPU board, and input/output modules. A sufficient number of NCUs shall be supplied to fully meet the requirements of this specification and the controls requirements shown on the drawings.
 - 1. Basis of design NCUs: Schneider Electric Continuum bCX1-CR-xxx with InfbCX1 controller.
- B. Webserver Functionality: All NCUs shall reside directly on the Owner's Ethernet TCP/IP LAN/WAN and shall be capable, out-of-the box, to be set up as a Web Server. The NCU shall have the ability to store HTML code and "serve" pages to a web browser. Provides the ability for any computing device utilizing a TCP/IP Ethernet connection and capable of running a standard Internet browser (Microsoft Internet Explorer™, Netscape Navigator™, etc.) to access real-time data from the entire BAS via any NCU.
 - 1. Graphics and text-based web pages shall be constructed using standard HTML code. The interface shall allow the user to choose any of the standard text or graphics-based HTML editors for page creation. It shall also allow the operator to generate custom graphical pages and forms.
 - 2. The WEB server interface shall be capable of password security, including validation of the requesting PC's IP address. The WEB server interface shall allow the sharing of data or information between any controller, process, or network interface (BACnet, LonTalk and TCP/IP) that the BMS has knowledge of, regardless of where the point is connected on the BAS network or where it is acquired from.
 - 3. The BAS network controller must act directly as the WEB server. It must directly generate HTML code to the requesting user (i.e. WEB browser), eliminating the need for and reliance on any PC-based WEB server hardware or software. To simplify graphic image space allocation, HTML graphic images, if desired, shall be stored in any shared network device. The BAS Web server shall have the ability to acquire any necessary graphics using standard pathing syntax within the HTML code mounted within the BAS WEB server. External WEB server hardware and software are not acceptable.
- C. Hardware Specifications
 - 1. Memory: A minimum of 4MB of RAM shall be provided for NCUs with expansion up to 8MB. The 8MB versions shall include a floating-point math co-processor.

2. Communication Ports: Each NCU shall provide communication to both the Workstation(s) and the field buses. In addition, each NCU shall have at least three other communications ports that support a telephone modem, portable service tool, serial printer and connection to third party controllers such as a chiller control panel. On a LAN/WAN system, the NCU shall be provided with a 10Mbps plug-in Ethernet TCP/IP network interface card (NIC).
3. Input/Output (I/O): Each NCU shall support the addition of the following types of inputs and outputs:
 - a. Digital Inputs for status/alarm contacts
 - b. Counter Inputs for summing pulses from meters.
 - c. Thermistor inputs for measuring temperatures in space, ducts and thermowells.
 - d. Analog inputs for pressure, humidity, flow and position measurements.
 - e. Digital Outputs for on/off equipment control.
 - f. Analog Outputs for valve and damper position control, and capacity control of primary equipment.
4. Modular Expandability: The system shall employ a modular I/O design to allow easy expansion. Input and output capacity is to be provided through plug-in modules of various types or DIN-mountable IOU modules. It shall be possible to combine I/O modules as desired to meet the I/O requirements for individual control applications.
5. Real Time Clock (RTC): Each NCU shall include a battery-backed, real time clock, accurate to 10 seconds per day. The RTC shall provide the following: time of day, day, month, year, and day of week. In normal operation, the system clock shall be based on the frequency of the AC power. The system shall automatically correct for daylight savings time and leap years and be Year 2000 compliant.
6. Power Supply: The power supply for the NCUs shall be auto sensing, 120-220VAC, 60/50 Hz power, with a tolerance of +/- 20%. Line voltage below the operating range of the system shall be considered outages. The controller shall contain over voltage surge protection, and require no additional AC power signal conditioning. Optionally, if indicated on the drawings, the power supply shall accept an input voltage of (-48 VDC).
7. Automatic Restart After Power Failure: Upon restoration of power after an outage, the NCU shall automatically and without human intervention: update all monitored functions; resume operation based on current, synchronized time and status, and implement special start-up strategies as required.
8. Battery backup: Each NCU with the standard 120-220VAC power supply shall include a programmable DC power backup system rated for a minimum of 72 hours of battery backup to maintain all volatile memory or, a minimum of 2 hours of full UPS including modem power. This power backup system shall be configurable such that at the end of a settable timeframe (such as 1 hour) of running on full UPS, the unit shall shut off full UPS and switch to memory retention-only mode for the remainder of the battery power. The system shall allow the simple addition of more batteries to extend the above minimum battery backup times.

D. Software Specifications

1. General: The NCU shall contain flash ROM as the resident operating system. Application software shall be RAM resident. Application software shall only be limited by the amount of RAM memory. There shall be no restrictions placed on the type of application programs in the system. Each NCU shall be capable of parallel processing, executing all control programs simultaneously. Any program may affect the operation of any other program. Each program shall have the full access of all I/O facilities of the processor. This execution of control function shall not be interrupted due to normal user communications including interrogation, program entry, printout of the program for storage, etc.
2. User Programming Language: The application software shall be user programmable. This includes all strategies, sequences of operation, control algorithms, parameters, and setpoints. The source program shall be English language-based and programmable by the user. The language shall be structured to allow for the easy configuration of control programs, schedules, alarms, reports, telecommunications, local displays, mathematical calculations, passwords, and histories. The language shall be self-documenting. Users shall be able to place comments anywhere in the body of a program. Program listings shall be configurable by the user in logical groupings.

E. Control Software:

1. The NCU shall have the ability to perform the following pre-tested control algorithms:
 - a. Proportional, Integral plus Derivative Control (PID)
 - b. Two Position Control
 - c. Digital Filter
 - d. Ratio Calculator
 - e. Equipment Cycling Protection
2. Mathematical Functions: Each controller shall be capable of performing basic mathematical functions (+, -, *, /), squares, square roots, exponential, logarithms, Boolean logic statements, or combinations of both. The controllers shall be capable of performing complex logical statements including operators such as >, <, =, and, or, exclusive or, etc. These shall be able to be used in the same equations with the mathematical operators and nested up to five parentheses deep.
3. Energy Management Applications: NCUs shall have the ability to perform any or all of the following energy management routines:
 - a. Time of Day Scheduling
 - b. Calendar Based Scheduling
 - c. Holiday Scheduling
 - d. Temporary Schedule Overrides
 - e. Optimal Start
 - f. Optimal Stop
 - g. Night Setback Control
 - h. Enthalpy Switchover (Economizer)
 - i. Peak Demand Limiting
 - j. Temperature Compensated Duty Cycling
 - k. CFM Tracking

- l. Heating/Cooling Interlock
 - m. Hot/Cold Deck Reset
 - n. Free Cooling
 - o. Hot Water Reset
- 4. History Logging: Each controller shall be capable of logging any system variable over user defined time intervals ranging from 1 second to 1440 minutes. Any system variables (inputs, outputs, math calculations, flags, etc.) can be logged in history. A maximum of 32,767 values can be stored in each log. Each log can record either the instantaneous, average, minimum or maximum value of the point. Logs can be automatic or manual. Logged data shall be downloadable to the Operator Workstation for long term archiving based upon user-defined time intervals, or manual command.
- 5. Alarm Management: For each system point, alarms can be created based on high/low limits or conditional expressions. All alarms shall be tested each scan of the NCU and can result in the display of one or more alarm messages or reports.
- 6. Up to 8 alarms can be configured for each point in the controller.
 - a. Messages and reports can be sent to a local terminal, to the front-end workstation(s), or via modem to a remote-computing device.
 - b. Alarms shall be generated based on their priority. A minimum of 255 priority levels shall be provided.
 - c. If communication with the Operator Workstation is temporarily interrupted, the alarm shall be buffered in the NCU. When communications return, the alarm shall be transmitted to the Operator Workstation if the point is still in the alarm condition.
- 7. Reporting: The NCU shall be able to generate user-definable reports to a locally connected printer or terminal. The reports shall contain any combination of text and system variables. Report templates shall be able to be created by users in a word processing environment. Reports can be displayed based on any logical condition or through a user command.

2.4 STANDALONE CONTROL UNIT (SCU) PANEL

- A. SCUs shall be microprocessor based, multi-tasking, multi-user, real-time digital control processors designed to integrate multiple Unitary Controllers, provide central processing capacity and integration of distributed processing, and interface directly with the system OWS and LAN.
- B. Each SCU panel shall consist of modular hardware with plug-in enclosed processors, communication controllers, power supplies, and input/output modules. A sufficient number of controllers shall be supplied to fully meet the requirements of this specification.
- C. The basic elements of the direct digital control system structure shall consist of standard components kept in inventory by the equipment supplier. The components shall not require customizing other than setting jumpers and switches, adding firmware modules or software programming to perform required functions.

- D. The system shall be capable of being expanded to its full capacity by adding sensors and entering programs in available random access memory (RAM). Future expansion shall not require hardware modifications to the controller.
- E. SCU shall be listed in accordance with UL 864 as required to provide direct control of all smoke dampers.
- F. Memory: Provide with sufficient memory to meet system performance requirements and support its own operating system, database system, and database including:
 - 1. Control processes
 - 2. Energy management applications
 - 3. Alarm management
 - 4. Historical/trend data for all points
 - 5. Maintenance support applications
 - 6. Custom processors
 - 7. Operator I/O
 - 8. Dial-up communications
 - 9. Manual override monitoring
- G. Point Types: Support the following types of point inputs and outputs:
 - 1. Digital inputs for status/alarm contacts
 - 2. Digital output for on/off requirement control
 - 3. Analog inputs for temperature, pressure, humidity, flow and position measurements.
 - 4. Analog outputs for valve and damper position control, and capacity control of primary equipment.
 - 5. Pulse inputs of pulsed contact monitoring.
- H. Expandability:
 - 1. The system shall be modular in nature, and shall permit easy expansion through the addition of software applications, workstation hardware, field controllers, sensors, and actuators.
 - 2. The system architecture shall support expansion capacity of all type of SCU panels, and all point types included in the initial installation.
- I. Serial Communication Ports: Provide at least two RS-232C serial data communication ports for simultaneous operation of multiple operator I/O devices such as industry standard printers, laptop workstations, PC workstations, and panel mounted or portable Operator's Terminals. SCU panels shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers, or network terminals.
- J. Hardware Override Switches:
 - 1. Provide the ability to manually override automatically executed commands at the SCUs via local, point discrete, onboard hand/off/auto operator override control via local keypad function for binary control points and with modulating control for analog control type points.

K. Hardware Override Monitoring:

1. SCU panel shall monitor the status or position of all override, and include this information in logs and summaries to inform the operator that automatic control has been inhibited. EMCS panel shall also collect override activity information for daily and monthly reports.

L. Local Status Indicator Lamps:

1. The SCU panel shall provide local status indication for each binary input and output for content, up-to-date verification of all point conditions without the need for an operator I/O device.

M. Integrated On-Line Diagnostics:

1. Each SCU panel shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all subsidiary equipment. The SCU panel shall provide both local and remote annunciation of any detected component failures, or repeated failure to establish communication. Indication of the diagnostic results shall be provided at each SCU panel, and shall not require the connection of an operator I/O device.

N. Sure and Transient Protection:

1. Isolation shall be provided at all network terminations, as well as all field point terminations to suppress induced voltage transient consistent with IEEE Standard 587-1980. Isolation levels shall be sufficiently high as to allow all single wiring to be run in the same conduit as high voltage wiring where acceptable by electrical code.

O. Power failure:

1. In the event of the loss of normal power, there shall be an orderly shutdown of all SCU panels to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data, and battery back-up shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.
2. Upon restoration of normal power, the SCU panel shall automatically resume full operation without manual intervention.

P. No digital control panel shall be loaded to more than 80% of its total available point capacity of the digital/analog/input/output sections.

Q. The SCU shall perform its assigned control and energy management functions as a stand-alone unit. Stand-alone control shall include, but not be limited to:

1. Supply and/or water reset.
2. Adaptive optimal start.
3. Time of day start/stop.
4. Zero energy band.
5. Duty cycle.
6. Control valve, damper, motor and alarm capabilities.

- R. EMCS Shall Operate Within The Following Limits:
1. Temperature 32°F to 120°F.
 2. Humidity 0 to 95% RH.
 3. Voltage +/- 10%.
- S. Control algorithms shall be available and resident in the EMCS to permit proportional, integral, derivative, incremental, floating and two position control modes in combination to meet the need of the application and to adapt to job conditions.
- T. Control shall be performed in a digital manner using the digital signal from the microprocessor based controller converted through electronic circuitry for modulation of electric or pneumatic actuators. This may take the form of a pulse width modulated signal or a true analog signal generated through a D/A convertor. Electro-pneumatic transducers used for pneumatic outputs shall be cabinet mounted either within the controller or in separate cabinet located immediately next to the digital control panel.
- U. Adjustments of control variables shall be available at the controller with the modem through a non-intelligent terminal. Hand held or mounted in cabinet face. If hand held devices are provided two shall be furnished. These adjustments shall include, but not be limited to, setpoints, proportional gain, integral rates, the velocity and acceleration constants associated with incremental control and on/off values of two-position control.
- V. The controller shall contain necessary mathematic, logic, utility functions, all standard energy calculations and control functions in ROM. These should be available in combination for programming the unit. These routines shall include, but not be limited to:
1. Math routines:
 - a. Basic arithmetic.
 - b. Binary logic.
 - c. Relational logic.
 - d. Fixed formulas for psychrometry.
 - e. Calculations.
 2. Utility routines for:
 - a. Process entry and exit.
 - b. Keyboard functions.
 - c. Variable adjustments and output.
 - d. Alarm indication.
 - e. Restart.
 3. Control routines for:
 - a. Signal compensation.
 - b. Loop control.
 - c. Energy conservation.
 - d. Timed programming.

- W. Final field programs shall be stored in battery backed up RAM. The EMCS (SCUs, UCs, etc.) shall be supplied with a minimum of eight hours of battery backup for the RAM with an automatic battery charger.
- X. The EMCS shall be expandable by adding additional SCUs, UCs, etc., that operate through the processor of the EMCS.
- Y. Provide digital sensors, differential air and/or water flow switches, space temperature sensors (30°F to 90°F), outside and air temperature sensors (-30°F to 120°F), hot water temperature sensor (0°F to 300°F), chilled water sensors (30°F to 90°F), humidity sensors, static pressure sensors, and other sensors and switches required to perform functions as specified.
- Z. The EMCS software shall contain a self-test procedure for checking the annunciator lights on the digital display, and the computer.
- AA. Variable shall be identified as being reliable or unreliable. When a calculation is required to use a value (sensed or calculated), which is identified as being unreliable, the unreliable data value will flash. The calculation will use a default value programmed into the unit.
- BB. Alarms (e.g. a pump that did not start) and deviation alarms (e.g. temperature out of limits) will be annunciated.
- CC. The SCUs, UCs, shall be enclosed in a metal cabinet. The cabinet shall be constructed such that it can be mounted and electrical terminations made during the construction phase of the project.
- DD. The EMCS cabinet shall be a hinged metal type with a baked enamel finish and provided with a key lock. Cabinets on each installation shall utilize one master key. Control wiring and system communications shall be electrically terminated inside the EMCS on a suitable termination board.

2.5 CONTROL UNITS

- A. Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.
- B. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.
- C. Stand-alone mode control functions operate regardless of network status. Functions include the following:
 - 1. Global communications.
 - 2. Discrete/digital, analog, and pulse I/O.
 - 3. Monitoring, controlling, or addressing data points.
 - 4. Software applications, scheduling, and alarm processing.
 - 5. Testing and developing control algorithms without disrupting field hardware and controlled environment.

D. Standard Application Programs:

1. Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, on-off control with differential sequencing, staggered start, antishort cycling, PID control, DDC with fine tuning, and trend logging.
2. HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy switchover.
3. Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.
4. Remote communications.
5. Maintenance management.
6. Units of Measure: Inch-pound and SI (metric).

E. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.

2.6 LOCAL CONTROL UNITS

- A. Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.
- B. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
- C. Stand-alone mode control functions operate regardless of network status. Functions include the following
 1. Global communications.
 2. Discrete/digital, analog, and pulse I/O.
 3. Monitoring, controlling, or addressing data points.
- D. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.

2.7 I/O INTERFACE

- A. Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.
- B. Binary Inputs: Allow monitoring of on-off signals without external power.
- C. Pulse Accumulation Inputs: Accept up to 10 pulses per second.

- D. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
- E. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.
- F. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA) with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer.
- G. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
- H. Universal I/Os: Provide software selectable binary or analog outputs.

2.8 POWER SUPPLIES

- A. Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:
 - 1. Output ripple of 5.0 mV maximum peak to peak.
 - 2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
 - 3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.
- B. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:
 - 1. Minimum dielectric strength of 1000 V.
 - 2. Maximum response time of 10 nanoseconds.
 - 3. Minimum transverse-mode noise attenuation of 65 dB.
 - 4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

2.9 UNITARY CONTROLLERS

- A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.
 - 1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72-hour battery backup.
 - 2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform scheduling with real-time clock. Perform automatic system diagnostics; monitor system and report failures.

3. Enclosure: Dustproof rated for operation at 32 to 120 deg F.

2.10 ANALOG CONTROLLERS

- A. Step Controllers: 6- or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.
- B. Electric, Outdoor-Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable set point, scale range minus 10 to plus 70 deg F, and single- or double-pole contacts.
- C. Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.
 1. Single controllers can be integral with control motor if provided with accessible control readjustment potentiometer.

2.11 SILICON CONTROLLED RECTIFIER (SCR) CONTROLLERS

- A. Designed to provide modulating electric resistance load control of three phase voltage and power to a variety of loads, this device may be referred to as simply an SCR elsewhere in these documents.
- B. Two or three SCRs as required for control, contained in a module, in an inverse parallel configuration, with distributed zero-cross firing control.
- C. Accepts a variety of command signal inputs including 0-5vdc, 0-10vdc, 4-20mA and delivers load power directly proportional to the command signal.
- D. The firing circuit, gate drivers and all associated circuitry and power and control terminals are laid out on a single board on a heat sink. Include three fast acting fuses, inside the controller, to protect the SCRs from typical fault currents. Terminals are electrically isolated from the line and load voltages and all are electrically isolated from the heat sink. The circuit card, which is powered from the 4-20mA signal, controls the ON and OFF time of the SCRs.
- E. Linearity of output power / voltage proportional to within 2% of command signal.
- F. Provide SCRs over 70A capacity with electronic interlock designed to prevent synchronous firing and resultant unbalanced load spiking for up to ten similar devices, similar to CCI Sync-Guard.
- G. Provide SCRs over 70A capacity with electronic controls that eliminate the DC load voltage and current that can exist with zero-cross operation, protecting load transformers from over heating, similar to CCI Trans-Guard.
- H. Design make: Control Concepts, Inc. Manufacturer's of similar equipment include HDR, Robacon, Indeco.

2.12 ELECTRONIC SENSORS

- A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.
- B. Analog Hydronic Flow Meters:
 - 1. Venturi Flowmeters:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Preso Meters; a division of Racine Federated Inc.
 - 2) S. A. Armstrong Limited; Armstrong Pumps Inc.
 - 3) Victaulic Company.
 - b. Venturi-type, calibrated, flow-measuring element with sensors for directional installation in piping.
 - 1) Design: Differential-pressure-type measurement for hydronic systems.
 - 2) Construction: Bronze, brass, factory-primed steel or stainless steel (material to match adjacent pipe), with valved pressure taps at the inlet and neck of the venturi and attached tag with flow conversion data.
 - 3) Minimum Rating: 250 psig/250 deg F.
 - 4) Machined bell-mouth entry and tapered conical static regain section such that the permanent pressure drop through the meter is less than 10% of the meter reading. Size venturi as indicated on drawings or if not indicated for maximum of 1 ft. wg. permanent pressure drop at design flow conditions.
 - 5) Provide differential pressure sensor across ports to read actual flow and log totalized flow with the EMCS. Cover complete operating range of equipment or system served. Include flow rate data compatible with sensor.
 - 6) Provide with all hoses, fittings, factory insulation where available, and all other accessories required for a complete installation.
 - 7) End Connections for NPS 2 and Smaller: Threaded.
 - 8) End Connections for NPS 2-1/2 and Larger: flanged or mechanically coupled.
 - 9) Flow Range: Cover operating range of equipment or system served, with minimum 10:1 turndown at +/- 3% repeatability and accuracy.
 - 10) Operating Instructions: Include complete instructions with each flowmeter.

C. Current Switches and Transducers:

1. Self-powered fixed setpoint digital output current switch to provide load status and power use trending data for small fixed loads only.
 - a. Solid or split core slips over loose power wiring (solid core) or clips over installed power wiring (split core).
 - b. Fixed on switch 0.25A max (solid core) or 0.15A (split core).
 - c. Capacity to 200A (solid core) or 150A (split core).
 - d. Digital switch output, rated 1A@30VAC/DC.
 - e. LED status light.
 - f. Operating conditions: -15 to 60 deg C, 0 to 95% rh.
 - g. Polarity insensitive.
 - h. 100% solid state.
 - i. CE and UL listed.
 - j. 5 year warranty.
 - k. Similar to Veris Hawkeye 600 (split core) or 800 (solid core).
2. Self-powered adjustable setpoint digital output current switch to provide load status, loss of belt/load, and power use trending data for small potentially variable loads.
 - a. Solid or split core slips over loose power wiring (solid core) or clips over installed power wiring (split core).
 - b. Adjustable on switch 1.0A max (solid core) or 0.5A (split core).
 - c. Capacity to 135A (solid core) or 175A (split core).
 - d. Digital switch output, rated 1A@30VAC/DC.
 - e. LED status light.
 - f. Hysteresis 10% max.
 - g. Operating conditions: -15 to 60 deg C, 0 to 95% rh.
 - h. Polarity insensitive.
 - i. 100% solid state.
 - j. CE and UL listed, RoHS compliant.
 - k. 5 year warranty.
 - l. Similar to Veris Hawkeye Hx08 series.
3. Self-powered analog current transducer to provide combination load monitoring, status, and power use trending data.
 - a. Solid or split core slips over loose power wiring (solid core) or clips over installed power wiring (split core)
 - b. Linear output from 0 to full scale.
 - c. 0-5Vdc or 4-20mA analog output
 - d. Operating conditions: -15-60 deg C, 0-95%rh.
 - e. 2 second response time.
 - f. Use solid core for new applications, split core for retrofits away from terminals.
 - g. +/- 2% of reading accuracy from 10% to 100%.
 - h. 100% solid state.
 - i. CE and UL listed, RoHS compliant.
 - j. 5 year warranty.
 - k. Similar to Hawkeye 722, 922/932, size and range as required for load.

4. Power Monitors:

- a. 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.

D. Static Pressure Transmitter / Transducer:

1. Senses differential gauge (static) pressures and converts this pressure difference to a proportional analog output signal.
 - a. Variable capacitance type, with stainless steel diaphragm and insulated positioning electrode.
 - b. Voltage Requirement (input): +/- 12 V DC.
 - c. Output: linear, 4 to 20 mA or 0 - 5 V DC.
 - d. Pressure ranges 0 to 0.1 in w.g. through 0 to 25.0 in. w.g.
 - e. Over Pressure Protection: Minimum 10 x full scale.
 - f. Pressure Part Volumes: Positive part - 0.020 in.³; reference part - 2.0 in.³
 - g. Accuracy: +/- 1% full scale (includes non-linearity hysteresis and non-repeatability).
 - h. Factory calibrated with zero span adjustment capability.
 - i. Temperature compensated output over the entire operating temperature range.
 - j. Operating Environments: 40 deg. F to 100 deg. F.

E. Airborne Contaminant Sensors:

1. Robust housing designed and NEMA rated for long-term continuous exposure to the environment where installed, able to withstand abuse, wear and tear, and occasional impact.
2. Sensitivity, accuracy, and repeatability to be certified as less than 10% of the lower of the OSHA, ACGIH, or NIOSH TLV (threshold limit value) for the TWA (time weighted average) exposure concentration.
3. Range 0-5X TLV.
4. Adjustable low and high limit alarm points.
5. Temperature and humidity self-compensating.
6. Operating range, 32 – 120 deg. F, 0-95% RH.
7. Output selectable 0-10Vdc or 4-20mA.
8. Local audible alarm.
9. Certified for contaminants listed in sequence or rated and listed for multiple contaminants.

F. Electronic Humidity Transmitter.

1. The electronic duct humidity transmitter shall sense duct humidity and shall transmit an electrical signal to the EMCS. A direct acting, proportional relationship shall be developed between the measured relative humidity and the transmitter output voltage,
2. Relative humidity shall be sensed by a cellulose acetate butyrate element and conveyed to a linear variable differential transformer. Changes in percent RH shall reposition the transformer core and create an imbalance in the secondary windings proportional to the magnitude of the RH sensed by the transmitter. The transmitter requires a +12 or +15 volt DC power supply. For a 10 to 100% RH input, the output shall be 0.5 to 5 volts with a +12 volt supply and 20 to 200 mV with a +15 volt supply. Change from one output range to the other shall be possible with a jumper.
3. The transmitter shall be provided with all electrical steel enclosure and cover; the element shall be protected with an aluminum guard.
 - a. Action: Direct Acting, Proportional.
 - b. Element: Cellulose Acetate; Butyrate-CAB.
 - c. Operating Range: 10 to 100% RH.
 - d. Supply Voltage: +12 volts DC, 60 mW (max.) or +15 volts supply -20 to 20 mV DC with a 15 volt supply.
 - e. Output Signal: 0.5 to 5.0 volts DC with a 12 volt supply -20 to 20 Mv DC with a 15 volt supply.
 - f. Load Resistance: 10k ohms with 0.5 to 5 volt output; 100k ohms with 20 to 200 Mv output.
 - g. Accuracy: $\pm 2\%$ of full scale (or RH) between 20 and 75% RH (includes non-linearity, hysteresis, and repeatability).
 - h. Operating Environment: 40 to 125E F, 10 to 90% RH, non-condensing.

G. Temperature Sensors:

1. Temperature sensors shall be:
 - a. Platinum wound RTD Type $\pm 1^\circ\text{F}$. Factory calibration point - 70°F at 1000 OHMS or 0°C at 1000 OHMS. Adjustments for zero and span. Output 4-20 mA.

Or (for non averaging sensors)

- b. Contractor may use thermistors which are compatible with system as follows:
 - 1) Accurate to 0.35°F over a range of -40° to 240°F ,
 - 2) Noncalibrated devices, accuracy traceable to NBS testing,
 - 3) Guaranteed stability of 0.2°F over a 15 year period,
 - 4) Interchangeable with any other in the new system, and
 - 5) Shielded cable not require for the guaranteed performance.

2. Room element assemblies shall be located in conditions representative of the zone, on an interior wall where air is free to circulate around the element but away from non-representative air conditions such as drafts or heat radiation. Mount the assembly 5 feet above the floor on a standard electrical wallbox, or as otherwise directed or required to obtain satisfactory results. A mounting bracket, wallplate, decorative cover and tamper resistant screens shall be furnished with the assembly. May be S.S. wall plate type where applicable.
3. Outside air temperature sensing: The outside air sensor shall be mounted where the effects of sunlight and radiant heat are at a minimum (north wall) for true “dry-bulb” reading. Provide in enclosure to fit 1/2" threaded rigid conduit, designed for exterior dry-bulb sensing. Seal off fittings shall be used to prevent condensation on the element in the housing. Monitoring range to suit controls.
4. Duct temperature sensors: Duct insertion sensors for fan discharge and other thoroughly mixed applications designed for control and/or indication shall have a single sensor with an accuracy of 0.25% of scale range. Provide averaging type sensing elements for transmitters and capillary thermostats in mixed air and coil discharge applications to counteract effects of stratification. Length as required to provide at least four full passes across the duct – two long dimension and two diagonal. Capillary systems to be fully compensated. The element shall consist of nickel wire encased in a copper tube. Monitoring range to suit controls.
5. Liquid temperature sensors shall be mounted in separable brass immersion wells with 1/2" - 14 NPT threads, filled with "Insulgrease" or other approved heat transfer compound. Monitoring range to suit conditions. Well and spring loading device to assure RTD contact with end of sensing well. Whenever a sensing element and well are installed in a chilled water line, plumber's putty or some other suitable sealant shall be applied around the adapter as well as the point where the two sensors leads pass through the adapter. This is to prevent condensation of moisture in the well and failure of the element. Minimum well length to be equal to 1/2 of the pipe diameter; match bulb length to well length.
6. Battery powered “wireless communicating” sensors which use batteries as the source of power for transmission and communication of data are not acceptable.

2.13 HVAC PROCESS FLOW CONTROL COMPONENTS

A. Automatic Air Dampers (AAD on drawings):

1. Provide all automatic dampers except those specified as being furnished by equipment manufacturer. Thermally Insulated Automatic dampers are required at all exterior wall and roof openings serving a HVAC purpose which are provided or modified as a part of this project, whether or not called for on the drawings. Control dampers to operate with sequence described later or as directed.
2. Single thickness and un-insulated airfoil blades are permitted where they are in series with air handler dampers.

3. Size dampers at full duct or damper size indicated on the drawings, arranged for flanged to duct rather than inserted in duct installation (clear damper opening, not outside of frame, equal to duct size indicated). If neither duct or damper size is indicated; size for maximum velocity of 1500 fpm and maximum pressure drop including transitions to and from duct 0.05 in w.g.
4. Materials:
 - a. General-service dampers not covered by the below restrictions, in galvanized steel ductwork, may be of galvanized steel construction.
 - b. Dampers in aluminum ductwork: aluminum or stainless steel.
 - c. Dampers subject to corrosive fumes: stainless steel of a type resistant to the fumes.
5. Overall Construction:
 - a. Damper frames fabricated of extruded aluminum sections or formed steel, with reinforced corner bracing, suitable for flange mounting to duct. Seal any and all gaps at frame joints to maintain airtight integrity of ductwork.
 - 1) Where flanged to duct mounting is not possible due to space restrictions or where Owner prefers access from inside duct, propose slip in style dampers on a case by case basis in damper submittal along with individual rationale for frame style selection.
 - b. Provide extruded aluminum airfoil construction for dampers modulating outside and return airflow, isolating lead/lag blowers, those operating on systems with over 2" water column potential close off pressure, and those operating over 1500 fpm.
 - c. Fasten aluminum frames with approved stainless steel fasteners, separated from dissimilar metal casing by dielectric gasketing.
 - d. Damper blades not more than 8" in width.
 - e. Mount blades on electroplated square or hexagonal steel shafting operating in stainless steel, bronze, or approved polymer sleeve bearings.
 - f. Provide corrosion resistant linkage and actuator mounting compatible with the damper materials and service, concealed in the frame outside of the airstream for flanged to duct applications and mounted in the airstream for slip in construction.
 - g. Provide parallel blade operation for all two position dampers, and opposed blade operation for modulating dampers, with exception of face and bypass dampers which shall be made up of two sections of parallel blade dampers with the blades of one damper opposed to the blades of the other for proper mixing.
 - h. Dampers over 48 in. in length and height shall be made into multiple sections.
 - i. Dampers shall be capable of sequencing as required.

- j. Provide AMCA Standard 511 certified class 1A leakage dampers, with maximum leakage not exceeding 3 cfm per square foot at 1 inch water gage pressure differential, or 8 cfm per square foot at 4 inches water gage pressure differential when held in the closed position with a torque of no more than 6 inch pounds per sq. ft.
 - k. Temperature range shall be suitable for the intended service.
6. Galvanized Formed Blade Construction Dampers:
- a. Frame of 16 gauge galvanized hat shaped channel.
 - b. Blades of single thickness 16 gauge interlocking formed galvanized steel.
 - c. Neoprene blade seals, and neoprene or compressible spring steel jamb seals.
 - d. Design make: Arrow Series 395.
7. Extruded Aluminum Airfoil Construction Dampers:
- a. Frames and airfoil blades of extruded aluminum construction.
 - b. Extruded polymer dampers seals with airstream inflatable double edges, mechanically locked in extruded blade slots, and easily field replaceable.
 - c. Blades jamb seals compressible spring stainless steel.
 - d. Design make: Ruskin Model CD-50 or equal.
- B. Valves:
1. Valve Types:
- a. Ball valves – full port for two position on/off service, with characterizing disc for modulating service.
 - b. Butterfly valves - two-position on/off service or for use in modulating service where specifically called out as such on drawings.
 - c. Globe valves - modulating service.
2. Valve Bodies:
- a. Screwed bronze bodies (2" size and smaller).
 - b. Flanged iron bodies (larger than 2" size).
 - c. Ball valves shall be of two piece full port stainless steel ball and stem design similar to those described in SECTION 23 05 23 – “General Duty Valves for HVAC Piping” but with reinforced actuator duty stems, adapters, and electronic actuators.
 - d. Butterfly valves shall be similar to those described in SECTION 23 05 23 – “General Duty Valves for HVAC Piping” with reinforced actuator duty stems, adapters, and actuators.
 - e. Globe valves shall have characteristic type throttling plug, #316 stainless steel or Monel stem, and removable composition seats, tight closing to class 4 standard minimum. Provided with necessary features to operate in sequence with other valves or damper operators and adjustable throttling range.

- f. Two or three way as required.
 - g. Designed for 125 psi operating pressure.
 - h. Arrange to spring return to fail-safe position as called for, quiet operating.
3. Two position valves to be full line size unless otherwise indicated. Modulating water control valves shall be sized on the basis of the smaller of 15% of the total system pressure drop or 8 ft. of water column pressure drop, based on the system design flowrates. Include valve pressure drops in submittal for review. Tag each valve before delivery to project site with scheduled valve identification for location and service.
 4. Provide valves and actuation so valves fail safe in normally open or closed positions as required to provide freeze, humidity, force, temperature, etc. protection. Fail position choice shall be submitted for review.
 5. Select two-way modulating valves to have equal percentage characteristics.
 6. Select three-way valves to have linear characteristics.

C. Actuators:

1. Electronic actuators:
 - a. Electronic actuators shall be motor driven with cast aluminum enclosure, with completely oil-immersed metal gear trains, sealed integral spiral spring return mechanism, force sensor safety stop, and shall have torque as needed to insure positive movement against system stall pressure. Furnish entire mechanism in housings designed for easy removal for service or adjustment.
 - b. Size each actuator motor to operate with sufficient reserve power to provide smooth modulating or 2-position action as specified.
 - c. Provide permanent split-capacitor, shaded pole, or synchronous motors with gear trains completely oil-immersed and sealed.
 - d. Equip motors for outdoor locations and for outside air intakes with "O ring" gaskets designed to make motors completely weatherproof, and equip with internal heaters to permit normal operation at -40 deg F (-40 deg C).
 - e. All actuators for exterior use shall be electronic style and shall have NEMA 4 enclosures with a rain shield covering the valve stem and entire actuator housing.
 - f. Damper actuators shall be direct-coupled over the damper shaft, and shall be installed without connecting linkage where possible.
 - 1) Where linkages are required, for example with multiple section dampers or dampers where actuator must be installed in the air-stream, provide with linkage furnished by the damper manufacturer and designed for the actuator being used.

- g. Ball and Butterfly valve actuators shall be direct-coupled over the valve shaft, installed without connecting linkage.
 - 1) Globe valve actuators shall have a rack and pinion linkage provided by the valve manufacturer and designed for the actuator being used.
- h. The actuator shall have electronic overload and digital rotation sensing to prevent damage to the actuator through the entire rotation range of the actuator.
- i. Actuators shall be capable of both clockwise and counter clockwise motion by changing mounting orientation.
- j. Provide proportional actuators for modulating services that accept a 0 to 10 VDC or 4 to 20mA control input and provide a 2 to 10 VDC or a 4 to 20mA operating range. An actuator capable of accepting a pulse width modulated / floating point control signal and providing full proportional operation is only acceptable for hydronic valve services where there is no connection to outside air.
- k. All 24 VAC/DC actuators shall operate on Class 2 wiring and shall not require more than 10 VA for AC or more than 8 watts for DC applications. Actuators operating on 120VAC power shall not require more than 10VA. Actuators operating on 230VAC power shall not require more than 11VA.
- l. All actuators shall have an external manual gear release and actuators with more than 60 in-lb torque capacity shall have a manual crank to allow manual positioning when the actuator is not powered.
- m. All modulating actuators shall have an external, built-in switch to allow the reversing of direction of rotation.
- n. Actuators shall be provided with a conduit fitting and minimum three foot electrical cable and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections.
- o. Actuators shall be UL Standard 873 listed and CSA Class 4813 02 certified as meeting correct safety requirements.
- p. Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuators rated torque and shall have a minimum 2-year manufacturer's warranty, starting from the date of installation.
- q. Design make: TAC-I/A *DuraDrive* series and Belimo models as required by torque.

2.14 SAFETY DEVICES

- A. Low Limit: Electric type with 20' long serpentine element, coldest foot sensitivity, with automatic reset and auxiliary contacts to the EMCS. Set for 37 deg. F for "freeze" protection and 55°F for fan discharge application.
- B. High Limit: Electric type, with manual reset; and auxiliary contacts to the EMCS, UL listed for fire, set for 125 deg. F.

- C. Air Flow Switch: Electric, differential pressure type or equivalent.
- D. Filter switches: Differential pressure type with adjustable set point, visual and audible trip indication, and auxiliary contacts to the EMCS.

2.15 MISCELLANEOUS DEVICES

- A. Provide all necessary relays, controllers, accumulators, positioners, switches, solenoids, transformers, temperature sensors, and transducers for a complete system.
 - 1. Locate these devices on local panel or enclosure adjacent to controlled equipment as required by codes and so as to facilitate service and maintenance, unless specified otherwise.
- B. Relays:
 - 1. Cube Type and Panel Mounted Relays:
 - a. SPDT or DPDT as required by application.
 - b. Cube type enclosure designed to mount on exterior of adjacent junction enclosure.
 - c. Track mount designed to mount on interior of panel or equipment adjacent junction enclosure.
 - d. Contact ratings: 10A resistive @ 120 - 277Vac, 1/3HP NO 120-240Vac, 10 million cycles minimum.
 - e. 10-30 Vac/dc to 120 or 208/277 Vac coil as required.
 - f. LED status light.
 - g. Operating time 20mS max.
 - h. Operating conditions: -15 to 60 deg C, 0 to 95% rh.
 - i. CE and UL listed for plenum installation, RoHS compliant.
 - j. 5 year warranty.
 - k. Similar to Functional Devices, Inc., RIBU / RIBH series (cube type) and RIBMU series (track mount).
 - 2. Combination Status Sensor / Relay / HOA Motor Control Devices:
 - a. SPDT or DPDT as required by application.
 - b. Enclosure designed to mount on exterior of adjacent junction enclosure.
 - c. Contact ratings: 1HP NO/NC 120Vac, 10 million cycles minimum.
 - d. Operating time 20mS max.
 - e. Integral HOA switch.
 - f. 10-30 Vac/dc to 120 or 208/277 Vac coil as required.
 - g. Adjustable current sensing on switch 0.5A to 20A.
 - h. Current sensor capacity to 20A.
 - i. Digital switch output, rated 1A@30VAC/DC.
 - j. LED status light.
 - k. Hysteresis 10% max.
 - l. Operating conditions: -15 to 60 deg C, 0 to 95% rh.
 - m. CE and UL listed for plenum installation, RoHS compliant.
 - n. 5 year warranty.
 - o. Similar to Veris Hawkeye H548.

C. Wiring:

1. Controls power wiring: Provide wiring in accordance with requirements of Section 23 05 13 , Division 26, and the National Electrical Code.
2. Controls communications and data cabling:
 - a. Provide plenum rated cables, in full accordance with the requirements of Divisions 26 (Electrical) and 27 (Communication).
 - b. Provide cabling as recommended in writing by the controls manufacturer for optimized communications, similar to:
 - 1) 22AWG single twisted pair, low capacitance (12.5pF/ft), shielded or unshielded plenum rated cable for low voltage communications.
 - 2) 18AWG single twisted pair, low resistance (6mW/ft), shielded plenum rated cable.
3. Controls communications and data fiber optic cabling: Provide in accordance with the stricter of the requirements of Divisions 26, 27, and the written recommendations of the manufacturer of the equipment served.
4. Where additional wire to wire terminations are required beyond end device and controller termination strips, make connections using NEMA rated termination blocks with barrier isolated strip/screw or tube/screw connections, all labeled for current function. Flying splices not permitted.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Examine conditions under which materials and methods are to be installed and notify Architect in writing of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in acceptable manner.
1. Installation indicates conditions are acceptable to Contractor as required to ensure requirements for applicable warranty or guarantee can be satisfied.
 2. Electrical Wiring: Check all electrical wiring associated with equipment for compliance with specifications and correctness of connections. Correct wiring in event equipment or devices fail to function in specified manner, whether due to incorrect connections or improper information and wiring diagrams.
 3. Verify that conditioned power supply is available to control units and operator workstation as required.

3.2 WORK INCLUDED

- A. Provide all labor, materials, equipment, and services required for the complete removal of all existing controls components being replaced or upgraded as a part of this project or which serve equipment being removed as a part of this contract.
 - 1. Insure that controls for areas outside of this contract's work remain intact and functional. Report any existing problems with functionality before demolition. New problem areas not otherwise a part of this scope that result from this demolition work: rebuild original functionality or upgrade to be included in the new controls.
- B. Provide all labor, materials, equipment, and services required for the complete EMCS installation, including Related Work, as required in the Contract Documents. Provide all programming labor required for creating the specified sequences of operation and associated graphics. Include labor required for integrating any software and programming enhancements made both during construction and commissioning and during the warrantee period. Include labor for any programming modifications required due to special circumstances not adequately described in the written sequences of operations, as required to control systems operation as intended.
- C. Provide all controls wiring required to connect devices furnished as part of or adjunctive to this EMCS regardless of the source of supply. Provide connections to Owner's LAN, WAN, telephone, and internet as required to perform controls work. Coordinate all fiber optic, telecommunications, and other electrical connections with Owner.
- D. Provide power wiring for controls requiring connection to AC power. Control circuits to be 120 vac maximum. Install wiring in accordance with requirements of SECTION 23 05 13 - COMMON ELECTRICAL REQUIREMENTS FOR HVAC EQUIPMENT, Division 26, and the National Electrical Code. Provide actuator power wiring to all automatic dampers including fire/smoke dampers. Coordinate required relays, etc.. with fire alarm system control wiring by Division 28.
- E. Provide all necessary devices required for proper system operation, including special electrical switches, conditioned power supplies, transformers, disconnect switches, relays, circuit breaker protection, as required.
- F. Provide all controllers, actuators, sensors, etc. as specified later herein, and as required to meet the specified sequence of operation.
- G. Furnish all valves, control wells, and dampers to Contractor responsible for their installation, as specified and as required to meet the sequence of operation.
- H. Provide interface connections from EMCS hardware to equipment starting circuits, alarms, etc.
- I. The system shall include all accessory equipment and electrical wiring to fulfill the intent of this specification, including all control and communications components required to interface with the Owner's Ethernet LAN, forming a complete and interoperable system.
- J. Each portion of the District EMCS system as described above shall include all gateways, translators, interpreters, software, programming, or other accessory devices as required to achieve BACnet communications over the LAN.

3.3 INSTALLATION

- A. System shall be installed and adjusted by trained mechanics and technicians, with a demonstrated experience of not less than (5) years, in the installation, adjustment, and repair of temperature control systems.
- B. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.
- C. Connect and configure equipment and software to achieve sequence of operation specified.
- D. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Components."
- E. Install hydronic instrument wells, valves, and other accessories according to Division 23 Section "Hydronic Piping."

3.4 SYSTEM COMPONENTS

- A. Current Switches and Transducers: As required; install per manufacturer's written instructions.
 - 1. Fixed setpoint digital output current switch: use only on fixed direct drive loads with no variability, under 0.5Kw, including small constant speed direct drive fans and pumps, and similar equipment.
 - 2. Adjustable setpoint digital output current switch: use only on fixed but potentially variable loads including belt driven or coupled loads and similar conditions, under 0.5Kw. Adjust to sense broken belt or coupling or other loss of primary load while motor continues to run.
 - 3. Analog Current Transducers: use on variable current / variable power loads and all loads above 0.5Kw including ECM fans, larger fans and pumps, and similar equipment.
 - a. Where Variable Frequency Motor Controllers are used, monitor current / power and status through VFMC equipment interface to controls system.
 - 4. Power Monitors: use on three phase loads without other comparable power use monitoring. Size and use for whole building loads as specified for Electrical Demand Monitoring and Control if integration to utility meter for comparable data is not available.
- B. Static Pressure Transmitter: As required; install per manufacturer's written instructions.
- C. Electronic Duct Humidity Transmitter: As required; install per manufacturer's written instructions.
- D. Temperature Sensors: Install per manufacturer's written instructions, in locations representative of the controlled spaces' temperature as required for proper control. Include proposed sensor locations in wiring diagram submittal.

1. Provide room temperature sensors for all spaces where thermostats are not specifically called for, as required to properly and individually control all building mechanical HVAC and domestic hot water equipment in accordance with the sequence of operation. For large spaces, provide at least one room sensor per 2000 square feet, in locations representative of the room's various exposures and internal loads.
 2. Temperature Sensor with Guard: Provide sensor with guard (preferably S.S. wall plate sensor) wherever temperature sensor is called for in publicly accessed spaces similar to corridors, vestibules, lobbies, stairwells, cafeteria, gymnasium, auditorium, etc..
 3. Duct and pipe temperature sensors: Provide as shown on the controls schematics and as required to properly control per the written sequence of operations.
 4. Outdoor air sensors: Provide as required to accurately sense outdoor air conditions for proper economizer control, at least five separate locations facing each of East, West, North, and South, as well as a representative rooftop location.
- E. Automatic Dampers: Furnish dampers, tagged for proper location, (with multiple section damper linkages). Install per manufacturer's printed instructions. Adjust to close tightly. Allow for conduit sleeve or blank space for roof fan dampers.
- F. Valves: Install with union or flanged connection. Locate close to apparatus controlled with pipe reducers and increasers located adjacent to valve. Locate, arrange, and pipe per installation diagram in an upright position (stem vertical).
- G. Actuators: Install per manufacturer's printed instructions as to motor size and quantity, linkage arrangement, drive connection point. Where ducts or valves are insulated, set damper operators at least 2 in. away from equipment to allow for insulation.
- H. Safety Devices:
1. Low Limit: Install on all equipment handling both water and any percentage of unheated outside air, including equipment in boiler rooms handling combustion air, serpentine on the discharge face of heating and/or cooling coils, or elsewhere as required for proper freeze protection, set at 37 deg F. Low limit trip shall report an alarm to the EMCS, which shall prevent the unit's fans from operating (not applicable to boiler burner fans), cause full flow of water in elements being protected, and fully close the outside air intake and exhaust air dampers until automatically reset (combustion air dampers shall not be closed when combustion is required for building heating). If some other sequence is required for proper freeze protection of special equipment or circumstances, provide this and detail in submittal.
 2. High Limit: Install in the supply medium at the discharge of each fuel fired appliance. High limit trip shall report an alarm to the EMCS, which shall prevent the unit's burner from operating until manually reset.
 3. Filter switches: Install across each bank of air filters in each air handling system.

4. Airborne contaminant Sensors: Install in locations most likely to sense contaminant in question, calibrated for reasonable levels of safety while avoiding nuisance trips, in each space where called for by sequence of operations or as otherwise shown on the drawings.
- I. Surge suppression (sp) receptacle: As required; install per manufacturer's written instructions.
- J. Miscellaneous Devices: As required; install per manufacturer's written instructions.

3.5 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."
- B. Install building wire and cable according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- C. Install signal and communication cable according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
 1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
 2. Install exposed cable in raceway.
 3. Install concealed cable in raceway.
 4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
 5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
 6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
 7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
- D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
- E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.6 SYSTEM SOFTWARE

- A. Provide completely installed and ready for use.
- B. System Configuration and Definition:
 1. All temperature and equipment control strategies and energy management routines shall be definable by the operator. System definition and modification procedures shall not interfere with normal system operation and control.

2. The system shall be provided complete with all equipment and documentation necessary to allow an operator to independently add, delete, or modify the following:
 - a. SCUs.
 - b. OWSs.
 - c. UCs.
 - d. Points of any type, and all associated point parameters and using constants.
 - e. Alarm reporting definition for each point.
 - f. Control loops.
 - g. Energy management applications.
 - h. Time and calendar based programming.
 - i. Totalization for every point.
 - j. Historical data trending for every point.
 - k. Custom control processes.
 - l. All graphic displays, symbols, and cross references to point data.
 - m. Dial-up telecommunication definition.
 - n. All operator passwords.
 - o. Alarm messages.
3. System Definition/control Sequence Documentation: All portions of system definition shall be self documenting to provide hard copy printouts of all configuration and application data. Control process and EMCS control loop documentation shall be provided in logical, graphical flow diagram format to allow control sequence to be easily interpreted and modified at any time in the future.
4. Database Save/Restore/Back-Up: Back-up copies of all standalone EMCS panel databases shall be stored in at least one personal computer operator workstation, and a secure electronic copy of the original complete database setup shall be stored at the offices of the TCS, available for the Owner's use.
5. Continuous supervision of the integrity of all EMCS panel databases shall be provided. In the event that any EMCS panel on the network experiences a loss of its databases for any reason, the system shall automatically download a new copy of the respective database to restore proper operations. Database back-up/download shall occur over the local area network without operator intervention. Users shall also have the ability to manually execute downloads of any or all portions of an EMCS panel database.

3.7 SCU PANEL LOCAL OR PORTABLE OPERATOR'S TERMINALS

- A. Each EMCS panel shall be capable of supporting an operator's terminal for local command entry, instantaneous and historical data display, and program additions and modifications.
 1. There shall be a provision for both permanently mounting the standalone EMCS panel operator terminal, or using it as a portable hand held unit.
 2. The EMCS panel operator terminal shall simultaneously display a minimum of 6 points with full English identification to allow an operator to view single screen dynamic displays depicting entire mechanical systems.

3. The operator functions provided by the EMCS panel operator terminal shall include, but not be limited to, the following:
 - a. Start and stop points
 - b. Modify setpoints
 - c. Modify PID loop setpoints
 - d. Override PID control
 - e. Change time/date
 - f. Add/modify start/stop weekly scheduling
 - g. Add/modify setpoint weekly scheduling
 - h. Enter temporary override schedules
 - i. Define holiday schedules
 - j. View analog limits
 - k. Enter/modify analog warning limits
 - l. Enter/modify analog alarm limits
 - m. Enter/modify analog differentials
 - n. Viewpoint history files
4. The EMCS panel operator terminal shall provide access to all real or calculated points in the controller to which it is connected, or any other controller in the network. This capability shall not be restricted to a subset of predefined "global points", but shall provide totally open exchange of data between the operator terminal and any EMCS panel in the network.
5. Operator access at all EMCS panel operator terminals shall be identical to each other, as well as identical to the PC or Laptop operator workstations. Any password changes shall automatically be downloaded to all controllers on the network.
6. The EMCS operator terminal shall provide English language prompting to eliminate the need for the user to remember command formats of point named. Prompting shall be provided consistent with a user's password clearance and the types of points being displayed, to eliminate the possibility of operator error.
7. A multifunction touch pad shall be provided for point and command selection, as well as parameter entry. To minimize the possibility of operator error, the EMCS panel operator terminal shall change the limit touch pad functions based upon an operator's password clearance, the function being performed, and types of points being displayed. Screen displays shall clearly indicate only valid touch pad functions.
8. Context Sensitive Help: On-line, interactive user's "Help" manuals and tutorials shall be provided. Based upon operator request, the "Help" function shall provide general system operating instructions and specific descriptions of commands available in the currently displayed menus.
9. Identification for all real or calculated points shall be consistent for all network devices. The same English language names used at PC workstations shall be used to access points at the EMCS panel operator's terminal to eliminate cross reference or look up tables.

10. In addition to instantaneous summaries, the EMCS panel operator's terminal shall allow a user to view a point history file for system points. Point history files shall provide a record of value of analog points over the last 24 hours, at 30 minute intervals, or a record of the last ten status changes for binary type points.

3.8 GENERAL CONTROLS SYSTEM PROGRAMMING DESCRIPTION

- A. Provide color graphic floor plan displays and system schematics detailing all mechanical and electrical systems as indicated in the sequence of operations, at least one for each system and piece of mechanical equipment, including air handling systems, chilled water systems, and heating systems. Create displays to represent logical grouping of system points or calculated data based upon building function, and mechanical system points which aid the operator in the analysis of the facility. The operator shall be able to view and control these systems via graphical and text-based displays and controls.
 1. Provide access to the various system schematic and floor plan graphics via any and all of mouse driven graphical penetration scheme, menu selection, "file tree" organization, or text based commands.
 - a. Graphical menu penetration: locate and display systems graphics via a mouse driven procedure, designed and implemented to optimize performance analysis and speed alarm recognition. Five clicks maximum from whole district map to details of critical alarm via this route.
 - 1) Whole District Map: Include each building shown as an active link; point and click to go to building. Display any building with (Owner defined, TCS implemented) alarms present as highlighted for rapid system review and diagnosis. Include at least three levels of alarm to facilitate prioritizing; each level shall be obvious and visually distinct. The most critical alarm in any building shall define the alarm level of that entire building in this graphic.
 - 2) Main Building Display: Include a full floor key plan of each floor, broken into areas of detailed floor plans, with similar active point/click penetration scheme and highlighted alarm areas.
 - 3) Detailed Floor Plans: Indicate the location of mechanical equipment (boilers, chiller, air handlers, duct and reheat / VAV systems, pumps and pumping systems, metering equip. etc.) and electrical equipment (switch gear, lighting, etc.) on the detailed floor plans. Highlight any systems when in alarm. Outline limits of each control zone (typically along walls, etc..) and provide active multicolored background for each zone. Zone background color shall change with space temperature deviation from setpoint, with a minimum of 8 background colors, colors to be distinct from alarm highlight colors.

4) System Specific Graphics: Provide pictorial schematically correct representations of each and every mechanical system controlled and/or monitored. Include all associated points, digital status, analog values, appropriate and/or significant calculated values, alarms, active adjustment of all user adjustable setpoints, links to all scheduling, trend logs, sequence of operations description, associated systems schematics in appropriate locations, etc. Include plain English descriptions of each active point / link shown. Include appropriate plain English warnings for alarms. Modify as required by Owner and Engineer during system review, start-up, and commissioning.

b. Menu and text based penetration: An operator request for information about a specific system shall cause the associated graphic display to be automatically selected and output on the viewing screen. The operator request may be entered via either the graphical menu penetration procedure or via a pull down directory tree style menu system with “specific building”, “specific mechanical room”, and “specific system” levels of identification. The pull down menu system shall cause the graphical menu system to be updated.

B. Graphic Representations

1. General: The program shall allow the operator to generate color graphics on-line using standard symbols selected from a standard library of symbols.
2. Provide customized graphics with dynamic point values and set points. Graphics shall include but not be limited to:
 - a. Each third party microprocessor controlled system with all points available.
 - b. Heating Hot Water System with heat injection systems, primary hot water system, secondary hot water systems, 3-ways, 2-ways, etc.
 - c. Air Handling Units, air and water sides, with coil pumps, zones, etc.
 - d. Floor Plans - The operator interface shall allow the user to access the various graphical schematics via a graphical penetration scheme of the floor plans. Minimum breakdown shall include:
 - 1) Whole District map, showing all buildings.
 - 2) Key plan of each building.
 - 3) Floor plans of each building with zoom in capability.

C. Time Schedule Programs

1. The programs for the EMS shall schedule each system's operation on an hourly basis controlled through daily, weekly and/or monthly schedules. Schedules for each individual system, room or area shall be programmed and modified by the user on a calendar-like display at the OWS.
2. The programs shall store 60 months of schedules.

3. An internal time clock shall automatically compensate for daylight savings time and calendars generated by software shall automatically compensate for leap years.

D. Trend Logs:

1. Provide customized trend log reports with up to twenty variables per report for each HVAC system. Points shall be assignable at the OWS; coordinate desired points on each log with Owner during training and commissioning. Archive trended values on the system hard disk for future inquiry, with back up copies automatically prompted for and generated on removable media.

E. Alarm Points

1. Alarm all temperature inputs to the DDC system (space, return air, mixed air, discharge air, supply and return water, boiler and cooling systems) at the OWS if the temperature is out of range 10 deg. F (adj.) above or below setpoint.
2. Monitor fan status with current sensing devices or differential pressure switch. If the fan is scheduled to run and the status is not proven, generate an alarm condition shown at the OWS.
3. Monitor pump status with current sensing devices. If the pump is scheduled to run and the status is not proven, generate an alarm condition at the OWS.
4. Monitor all alarm points of any stand alone controllers such as boiler burner controls, chiller or condensing unit controls, etc., and generate an appropriately annunciated alarm condition at the OWS.
5. For all alarms, provide appropriate text and graphical annunciation to facilitate ease of understanding of source and location of problem. Coordinate annunciation with Engineer, equipment manufacturers, and Owner's representatives.

F. Optimum Start and Stop Program

1. Bring the building from unoccupied control mode through a warmup / cooldown mode into occupied mode through a controlled optimum start program. Gradually change space temperature requirements from unoccupied to occupied setpoints over a predetermined time to not only bring the building to required temperature but also soft start building mechanical equipment.
2. Include warm-up/cool-down mode between unoccupied and occupied periods such that the temperature reaches occupied setpoint before occupied ventilation begins.
3. Each system shall have an independent modular program.
4. Minimize the total energy consumption during daily start-up and shut-down of each heating/cooling system via optimized timing and adjustment.
5. Compare the outside air temperature to space temperature, required setpoints, and historical startup and shut-down data to calculate optimized start and stop times for each system.

6. Adjust the timing for each system to bring its respective zone to occupied setpoint at the time of occupied mode start and to shut-down its respective zone as early as possible without letting the temperature drift out of the specified comfort range..
7. The optimum start / stop program shall be adjustable to the rate structure of the local energy company.
8. Incorporate an enhanced ventilation mode in the Optimum Start Program

G. Optimum Stop Program

1. Each system shall have independent modular program.
2. The program shall minimize the total energy consumption during daily shut-down of each heating/cooling system.
3. A control algorithm shall compare the outside air temperature to space temperature to calculate a stop time for each air handling system.
4. The stop time for each system shall shut-down its respective zone as early as possible without letting the temperature drift out of the specified comfort range.
5. Minimum outside air ventilation shall be maintained where required by occupied status requirements of space served.

H. Fire Alarm Fan Shut Down

1. When fire alarm condition is initiated, the fire alarm system shall directly cause all fans 1000 cfm and larger to shut down and shall provide a signal to the EMCS to note fire alarm condition.
2. When fire alarm condition signal is received from the fire alarm system, initiate the following sequence:
 - a. Cause all building fans 1000 cfm and larger to shut down. This is in addition to the direct shutdown caused by the fire alarm system.
 - 1) Allow variable speed drives to ramp down and ramp up on restart.
 - b. Cause all smoke dampers and fire-smoke dampers to close and remain closed for the duration of the alarm condition. Delay closing smoke dampers until associated fan system has completely stopped (10 sec. Maximum).
 - c. Do not permit unrelated HVAC equipment (heating valves, pumps, etc..) in building to lose control.
 - d. Provide separate control wiring, connections to fire alarm system, all required smoke dampers, etc..., as required to accomplish the required sequence.
 - e. Upon termination of the fire alarm condition as indicated by a signal from the fire alarm system, cause all automatic fire/smoke dampers to open and prove open, then return all affected fans to their normally scheduled operation using the demand limiting staggered start algorithm.

I. Day/night Setback

1. The day/night setback will consist of lowering the space heating setpoint and raising the space cooling setpoint during the unoccupied mode, thereby reducing the heating and cooling energy requirements. The occupied and unoccupied areas will be specified by the owner and will be coordinated with the control system.

J. Economizer Cooling Cycle

1. The controls shall incorporate an enthalpy logic center with outdoor and return air temperature and humidity sensors that shall maximize the use of outdoor air for cooling before the mechanical cooling is energized and during operation through comparison of outdoor and return air enthalpy as follows. Note that multiple outdoor temperature conditions will be present at different outside air intake locations, and as such a comparable number of outside air sensors are required. Some mechanical systems may share a single outdoor air enthalpy center, for example adjacent UVs each facing east, providing the outdoor air conditions can be demonstrated to be virtually identical from an energy management perspective. Provide at minimum East, West, South, North, and Rooftop outdoor air sensors.
2. When the outdoor air enthalpy is less than the return air enthalpy during cooling mode, the logic circuitry shall cause the outdoor and return air dampers to modulate to the balanced outdoor air position that satisfies the critical space temperature transmitter set point before cycling the condensing unit.
3. If the outdoor air enthalpy is less than the return air enthalpy and the critical space temperature transmitter set point cannot be satisfied with 100% outside air, then the system shall circulate 100% outside air and cycle the condensing unit to satisfy the zone temperature requirements.
4. If the enthalpy sensors indicate that the return air has lower enthalpy than the outdoor air, then the system shall revert to normal cooling mode.
5. Upon a call for cooling to maintain the night setback temperature, only the economizer mode shall be operational. The condensing unit shall not cycle, and upon satisfying the space temperature transmitter night setback set point, the system shall revert to the normal unoccupied mode.

K. Maintenance Management: Continuously totalize run hours for equipment controlled and/or monitored for use by the maintenance management program.

L. Equipment Scheduling

1. Equipment shall be capable of 7 days, 24 hours schedules with separate holiday hours.
2. There shall be capability for five different holiday schedules which can be selected from the occupancy schedule graphic.
3. Holidays shall be programmed so that they shall need a minimum of manual adjustment year to year and can easily be modified at front end if necessary.
4. All schedule programming shall reside in local controllers, but shall be configurable from the front end.

M. Coil Freeze Protection.

1. Heating and cooling coils and any other equipment provided as a part of this project which are circulating water (not required for glycol coils) or are otherwise subject to water freeze damage, subject to the following, that have any percentage of unheated outside air entering them, shall have coil freeze protection.
2. Mixed outside and return air and the preconditioned discharge air from air to air energy recovery units shall be considered unheated for this purpose.
3. The first stage of coil freeze protection shall incorporate analog input temperature sensing at the expected freeze location. Sensing devices may be immersion style return water temperature sensor piped as close as practical to the outlet of the coil (within the rooftop unit if applicable), surface temperature sensors on the coil surface at the expected freeze location, or other comparable devices approved as applicable to the circumstances. Include details of freeze protection scheme for all such equipment in submittal. When the sensed temperature is above 60°F (adj.), the coil control valve shall be under space temperature control. If at any time the expected freeze location sensed temperature drops below 60°F (adj.), the control valve shall temporarily open to raise that coil's return water temperature to above 80°F (adj.), and the EMCS shall report an alarm to the OWS
4. The second stage of coil freeze protection shall be the low limit freeze stat air temperature sensors with the sequence defined under safeties, above.

3.9 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
 2. Test and adjust controls and safeties.
 3. Test each point through its full operating range to verify that safety and operating control set points are as required.
 4. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
 5. Test each system for compliance with sequence of operation.
 6. Test software and hardware interlocks.
- C. DDC Verification:
1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
 2. Check instruments for proper location and accessibility.
 3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.

4. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
5. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
6. Check temperature instruments and material and length of sensing elements.
7. Check control valves. Verify that they are in correct direction.
8. Check DDC system as follows:
 - a. Verify that DDC controller power supply is from emergency power supply, if applicable.
 - b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
 - c. Verify that spare I/O capacity has been provided.
 - d. Verify that DDC controllers are protected from power supply surges.

D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.10 ADJUSTING

A. Calibrating and Adjusting:

1. Calibrate instruments.
2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
4. Control System Inputs and Outputs:
 - a. Check analog inputs at 0, 50, and 100 percent of span.
 - b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
 - c. Check digital inputs using jumper wire.
 - d. Check digital outputs using ohmmeter to test for contact making or breaking.
 - e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.
5. Flow:
 - a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
 - b. Manually operate flow switches to verify that they make or break contact.

6. Pressure:
 - a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
 - b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
 7. Temperature:
 - a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
 - b. Calibrate temperature switches to make or break contacts.
 8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
 9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
 10. Provide diagnostic and test instruments for calibration and adjustment of system.
 11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.
- B. Adjust initial temperature and humidity set points.

3.11 SYSTEM TESTING AND COMMISSIONING

- A. Test complete control system for control device operation prior to the systems acceptance. Demonstrate complete sequence of operations to Architect's and Owner's representatives.
1. Verify operation of system inputs and outputs, control loops and/or software programming, timing functions, operator entered constants, facilities management functions, etc., and observe that they perform their intended functions. Generate check out data sheets for each system so verified.
 2. Field verify analog input calibration, analog output operation, digital input function, digital output operation, and coordination of system inputs and outputs between system graphics and field devices for schematic accuracy. Coordinate device testing with Testing and Balancing Agency – refer to section 23 05 93 – Testing, Adjusting, and Balancing for HVAC for additional information. Generate check list of all devices, keyed with descriptive locations and functions, along with complete calibration, testing, and coordination data, certified by Contractor and TAB agency.
 3. Provide complete values and points logs, printed with hourly values for one week, demonstrating correct control functions and programming.

- B. When above procedure has been completed and control systems are operating satisfactorily, produce and submit a report of entire systems performance for review, including all data described above. Submit three copies to the Architect's Representative advising them that the control system is 100% complete and operates in accordance with the Contract Documents.

3.12 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 23 09 00

SECTION 23 21 13 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes pipe and fitting materials, special-duty hydronic systems fittings, equipment, valves, and specialties, and joining methods for the following:
 - 1. Hydronic Systems piping.
 - 2. Make-up water piping
 - 3. Safety and relief valve piping.
 - 4. Blowdown and system drain piping.
 - 5. Air conditioning and boiler condensate drain piping.
 - 6. Air-vent piping.

1.3 PERFORMANCE REQUIREMENTS

- A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:
 - 1. Steel and Copper Hydronic Piping: 125psig at 250 deg F.
 - 2. CPVC Hydronic Piping: 90psig at 140 deg F.
 - 3. Makeup-Water Piping: 100 psig at 150 deg F.
 - 4. Safety-Valve-Inlet and -Outlet Piping, Vent and Drain Piping: Equal to the pressure and temperature of the piping system to which it is attached.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Above Grade Piping
 - 2. Pipe Fittings.
 - 3. Dielectric Fittings.
 - 4. Specialty Valves.
 - 5. Air and Pressure Control.
 - 6. Pressure Control
 - 7. Special Duty Hydronic Components.

- B. Shop Drawings: Include in coordination drawings details of the piping layout showing proposed piping routing including locations of offsets, fittings, elevations with drain and vent fittings, pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Provide enlarged details of congested areas, custom anchor fabrication, and other details as required to clearly delineate the proposed construction.
- C. Welding Quality Control Submittals
 - 1. When welded or brazed pipe work is required or proposed as a part of this project, submit following for approval before beginning any welding or brazing work:
 - a. Welding and Brazing Procedure Qualification: Prepare and submit for approval welding and brazing procedure qualification specification qualifying all proposed procedures as specified in Quality Assurance below with copies of all back-up data.
 - b. Welders' and Brazers' Certification: Submit for approval certification that each proposed welder, welding operator, brazer, or brazing operator has been qualified in all procedures proposed for that worker as specified in Quality Assurance below with copies of all back-up data.
- D. Qualification Data: For Mechanical Grooved and Pressure Sealed Joint Installers.

1.5 CLOSEOUT SUBMITTALS

- A. Field quality-control test reports.
- B. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with all applicable sections of the following:
 - 1. ANSI / ASME B 31.9: "Building Services Piping".
 - 2. ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualifications".
 - 3. New York State Labor Department Industrial Code Rule No. 4 (cited as 12 NYCRR4)
 - 4. New York State Labor Department Industrial Code Rule No. 14 (cited as 12 NYCRR14).
 - 5. Building Code of New York State.
 - 6. ANSI / ASHRAE 15 "Standard Safety Code for Mechanical Refrigeration".
 - 7. ASME label on all pressure vessels and safety valves.
 - 8. ANSI / ASME B31 – "Code for Pressure Piping".

B. Installer Qualifications:

1. Grooved Mechanical and Pressure Seal Joint Quality Control:

- a. Installer Certification: Provide installers trained in and familiar with the installation of the mechanical joint systems, certified by the approved joint manufacturer as having been trained and qualified to join piping with manufacturer's system.
- b. Single Source: Obtain mechanically joined piping system components from single approved manufacturer for each system type, grooved or pressed.
- c. Proper Tools: Fabricate and install joints using the proper tools, actuators, rolls, cutters, jaws, rings, etc., as manufactured and instructed by the approved manufacturer.
- d. Manufacturer's Inspection: Certify grooved system installation for compliance with manufacturer's recommendations.

C. Welded Support Work Quality Control:

1. Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Welded Piping Work Quality Control:

1. Welding and Brazing Procedure Qualifications: Qualify any welding or brazing procedure to be used on this Project in accordance with ASME "Boiler and Pressure Vessel Code", Section IX. Qualification may be made by technically competent group or agency (subject to approval) meeting the following conditions:
 - a. Group or agency qualifying the procedure meets all procedure qualification requirements of ASME "Boiler and Pressure Vessel Code", Section IX.
 - b. Contractor accepts full responsibility for procedure qualified.
 - c. Contractor has qualified at least one welder or welding operator using procedure qualified and provides record of qualification.
 - d. Contractor accepts full responsibility for qualified procedures by signing related qualification records with procedure and performance qualifications including all dates, results, and associated data.
2. Welders' and Brazers' Qualifications: Ensure that all welders, welding operators, brazers, or brazing operators employed for this project are qualified for all welding and brazing procedures, proposed as part of this Project, in accordance with ASME "Boiler and Pressure Vessel Code", Section IX. Qualification by previous employer or technically competent group or agency (subject to approval) may be acceptable if following information is included:

- a. Documentation that the previous qualification was for essentially the same procedures proposed and was in full accordance with ASME "Boiler and Pressure Vessel Code", Section IX.
 - b. Copy of performance qualification testing record showing who qualified the worker, date of qualification, and work history record showing continuous performance to maintain qualification.
- 3. Weld and Braze Qualification Records: Maintain and sign certified records of approved procedures used and approved qualified workers employed for welded and brazed joints performed as a part of Contract Work. Ensure all building services piping welding and brazing work can be traced to a specific procedure and welder.
- 4. Inspection and Examination by Owner, Remedy by Contractor: Owner reserves right to examine, inspect, and test all piping using visual, radiographic, or other recognized testing methods to determine compliance with specified quality control requirements and requirements of applicable regulatory agencies.
 - a. Cost of Owner's testing of acceptable installation provided at Owner's expense
 - b. Repair piping installations not passing Owner's quality inspection testing using approved method or replace at no additional cost.
 - c. Cost of initial testing of piping not conforming to specified requirements and any retesting of repairs or replacement work shall be deducted from Contract Sum.
- E. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Refer to Part 3 for Piping Applications Article.
- B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Anvil International, Inc.
 - 2. Cerro Flow Products, Inc.
 - 3. Mueller Industries, Inc.
 - 4. S. P. Fittings; a division of Star Pipe Products.
 - 5. Viega LLC
 - 6. Victaulic Company of America.
- C. Copper Tubing: ASTM B 88, Annealed or Drawn Temper, Types M, L, and K.

D. Copper Tube Fittings:

1. Solder Fittings

- a. Tees, Elbows, Reducers, Adapters: ANSI B16.22 streamlined pattern wrought copper or ANSI B16.18 cast bronze; solder end connections; ASTM B62.
- b. Unions: Solder type, cast bronze, ground joint, Class 150.
- c. Cast Bronze Flanges: ANSI B16.24 Class 150 solder connection flanges, raised ground face, ANSI pattern drilled and spot faced bolt holes.

2. Grooved-End Fittings and Couplings:

- a. Fittings: ASTM B 75, copper tube or ASTM B 584, bronze casting.
- b. Couplings: Rigid pattern, unless otherwise indicated; gasketed fitting. Ductile-iron housing with keys matching pipe and fitting grooves.
- c. Gaskets: Prelubricated EPDM gasket manufactured by coupling manufacturer, rated for minimum 250 deg F for use with housing, and steel bolts and nuts.

3. Pressure-Seal Fittings:

- a. Housing: Copper conforming to material requirements of ASME B16.18 or ASME B16.22 and performance criteria of IAPMO PS 117.
- b. Sealing elements: EPDM, factory installed by fitting manufacturer.
- c. Leakage path designed into un-pressed fittings assuring readily visible leakage of system liquids past the sealing element of any un-pressed connection.
- d. Tools: Manufacturer's special tools that compress fittings and effect pressure seal.
- e. Minimum 200-psig working-pressure rating at 250 deg F.

4. Mechanically Formed Tee Option:

- a. Outlet: formed by proprietary rotating tool expanding drilled side hole of main tube into precision collar.
- b. Branch Inlet: Formed by proprietary tool that radius clips tube ends matching circumference of main tube, and dimples indicating correct insertion depth and orientation that remain visible after brazing.
- c. Connection: Brazed joint, stronger than original main tube, with smoothly radiused branch entry and 0% flow obstruction.

2.2 STEEL PIPE AND FITTINGS

A. Refer to Part 3 for Piping Applications Article.

B. Steel Pipe: ASTM A53-S , A53-E, or A106 Schedule 40 or 80, seamless (type S) or electric-resistance welded (type ERW), Grade B, black or ASTM A123 and A153 galvanized steel pipe, plain or threaded ends.

C. Threaded Fittings:

1. Pipe threads in accordance with ANSI/ASME B1.20.1 National Pipe Thread taper (NPT) standards.
2. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.
3. Unions: ASME B16.39 malleable iron, threaded, Class 150 or higher, ground joint bronze to iron seat.
4. Cast-Iron Fittings: ASME B16.4; Class 125 or higher.
5. Malleable-Iron Fittings: ASME B16.3, Class 150 or higher.
6. Flanges: Cast Iron ASME B16.1 Class 125 or higher, raised ground face, ANSI pattern drilled and spot faced bolt holes.

D. Welded Steel Fittings: ASTM A 234/A 234M or A106 seamless forged steel.

1. ASME/ANSI B16.9 pattern with ASME/ANSI B16.25 beveled butt weld ends, wall thickness to match adjoining pipe.
 - a. Long radius pattern unless space restrictions prohibit, then short radius allowed.
2. ASME B16.11 socket weld class 2000.
3. Flanges: ANSI B16.5 Class 150 or higher, butt weld neck type, raised ground face, ANSI pattern drilled and spot faced bolt holes.
4. Where branch connections are two or more sizes smaller than main size, "weldolets" or "threadolets" are acceptable.
5. Fabricate custom bend angle fittings by removing material from standard butt weld type fittings at the appropriate angle and recreating the original ASME B16.25 weld configuration chamfer.
 - a. Shop or site-weld weld/groove adapter nipples to custom angle fitting where applicable to create custom angle grooved mechanical fittings.

E. Grooved Mechanical-Joint Fittings and Couplings:

1. All products – fittings, couplings, gaskets, and grooving tools - shall be manufactured by a single ISO 9001 or higher certified manufacturer.
2. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Anvil International, Inc.
 - b. Central Sprinkler Company; a division of Tyco Fire & Building Products.
 - c. Victaulic Company of America.

3. Mechanical Joint Fittings: ASTM A 536, Grade 65-45-12 Ductile Iron; ASTM A 47 Grade 32510 Malleable Iron; ASTM A 53, Types E or S, Grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders designed to accept grooved end couplings. Subject to applicable fitting requirements described elsewhere in this document. Basis of Design: Victaulic.
4. Mechanical Couplings: ASTM A 536, Grade 65-45-12 ductile iron or ASTM A 47 Grade 32510 malleable iron split housing, designed for bolted assembly with full circumferential engagement of coupling into pipe end or fitting groove or alternatively to grip exterior of plain steel pipe where grooving is not possible. Coupling houses pressure responsive gasket by coupling manufacturer that forms durable pressure seal. Provide rigid type couplings for all straight runs and flexible type couplings for all branch takeoff (side of tee) and elbow fittings, unless otherwise specified or directed. Provide couplings with bolt size and strength and pressure rating not less than the listed product.
 - a. Grooved End Mechanical Flexible couplings: pad to pad coupling fit with clearance to groove. Basis of Design: Victaulic Style 77.
 - b. Rigid Grooved End Mechanical Couplings: full circumference coupling to groove compression contact for rigid style groove couplings. Basis of Design: Victaulic Style 07 and Style 107.
 - c. Rigid Plain End Mechanical Couplings: Extra heavy housing with hardened toothed jaws set into housing that engage and grip pipe exterior as bolts are tightened. Basis of Design: Victaulic Style 99 Roustabout.
5. Pipe End Grooves: Pipes may be delivered to site full length with factory grooved ends fabricated to coupling manufacturer's specifications or shop or site fabricated to length required using coupling manufacturer's groove cutting or rolling tool, fabricated to coupling manufacturer's specifications.
6. Coupling Gaskets: Synthetic rubber gasket of central cavity pressure-responsive design manufacturer rated for fluid and temperature of service, minimum 300 psig working pressure at 250 degrees F.

2.3 PLASTIC PIPE AND FITTINGS

- A. CPVC Plastic Pipe: ASTM F 441/F 441M, Schedules 40 and 80, plain ends as indicated in Part 3 "Piping Applications" Article.
- B. CPVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM F 438 for Schedule 40 pipe; ASTM F 439 for Schedule 80 pipe.

2.4 JOINING MATERIALS

A. Flanges:

1. Gasket Materials:

- a. ASME B16.21, nonmetallic, flat, asbestos free, suitable for chemical, pressure, and thermal conditions of system.
- b. 1/8-inch maximum thickness unless thickness or specific material is indicated.
- c. Full or narrow face pattern to fit flanges.

2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, electroplated, unless otherwise indicated.

3. Provide dielectric kit for flanges joining dis-similar piping materials.

4. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

B. Solder Filler Metals: Use solder conforming to ASTM B 32-95; alloy grades Sn96, Sn95, Sn94, E, AM, WS; lead free alloys with maximum lead content of 0.1percent by weight, minimum solidus temperature of 430 deg. F, and approved for use with potable water. Higher lead content solder not acceptable. Include water-flushable flux according to ASTM B 813.

C. Brazing Filler Metals: Select brazing filler metals compatible with piping to be joined:

1. AWS A5.8 BCuP Series, copper-phosphorus alloys for joining copper with copper only.

2. AWS A5.8 BAg series, cadmium free silver bearing alloys for joining dis-similar metals including copper with any brass, bronze, steel, or stainless steels, or other dis-similar brazeable materials.

D. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

E. Solvent Cements for Joining Plastic Piping:

1. CPVC Piping: ASTM F 493.

- a. Use CPVC solvent cement that has a VOC content of 490 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- b. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), in contrasting color.

2.5 TRANSITION FITTINGS

A. Plastic-to-Metal Transition Fittings:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Charlotte Pipe and Foundry Company.
 - b. IPEX Inc.
 - c. KBi.
2. CPVC one-piece fitting with one threaded brass or copper insert and one Schedule 80 solvent-cement-joint end.

B. Plastic-to-Metal Transition Unions:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Charlotte Pipe and Foundry Company.
 - b. IPEX Inc.
 - c. KBi.
 - d. NIBCO INC.
2. MSS SP-107, CPVC union. Include brass or copper end, Schedule 80 solvent-cement-joint end, rubber gasket, and metal threaded union.

2.6 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper-alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials, designed to join dis-similar metallic piping materials with dis-similar metals separated by dielectric material in a configuration to minimize galvanic corrosion of the less noble piping material.
- B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Advance Products & Systems, Inc.
 2. Capitol Manufacturing Company.
 3. Central Plastics Company.
 4. Elster-Perfection Corporation.
 5. Hart Industries International, Inc.
 6. Lochinvar Corporation.
 7. Pipeline Seal and Insulator, Inc.
 8. Precision Plumbing Products, Inc.
 9. Sioux Chief Manufacturing Company, Inc.
 10. Victaulic Company of America.

11. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
12. Zurn Plumbing Products Group; AquaSpec Commercial Products Division.

C. All Materials: Suitable for system fluid, pressure, and temperature.

D. Dielectric Nipples:

1. Galvanized steel nipple with insert of noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

E. Dielectric Couplings:

1. Galvanized-steel coupling with insert of noncorrosive thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

F. Dielectric Unions:

1. Factory-fabricated union assembly, for 250-psig minimum working pressure at 180 deg F.

G. Dielectric-Flange Kits:

1. Flange assembly kit for field assembly. Include full-face or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, steel backing washers, and appropriately sized bolts and heavy pattern nuts. Provide bolts of length as required for full engagement in nuts, of higher strength if undersized for bolt sleeves as required to maintain system working pressure.

2.7 VALVES

A. Isolation, Check, Balancing, Vent, and Drain Valves: Comply with requirements specified in Section 23 05 23 -General-Duty Valves for HVAC Piping

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Section 23 09 00 - Instrumentation and Control for HVAC.

C. Safety Relief Valves:

1. Designed, manufactured, tested, and labeled in accordance with the requirements of Section IV of the ASME Boiler and Pressure Vessel Code.
2. Valve Body: Bronze, Brass, or Cast-iron, side outlet with all wetted internal working parts made of stainless steel, brass, and elastomers with 125 PSIG working pressure and 250 deg. F maximum operating temperature. Brass valve seat with Glass and carbon-filled PTFE disc.
3. Valve Size: Compliant with Section IV of ASME Boiler and Pressure Vessel Code, selected to suit system in which installed, with operating pressure and capacity factory set at full rated capacity of system at manufacturer's suggested working pressure.

4. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Amtrol, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Bell & Gossett Domestic Pump; a division of ITT Industries.
 - d. Conbraco Industries, Inc.
 - e. Spence Engineering Company, Inc.
 - f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2.8 THERMAL EXPANSION AND AIR CONTROL DEVICES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Amtrol, Inc.
2. Armstrong Pumps, Inc.
3. Bell & Gossett Domestic Pump; a division of ITT Industries.
4. Wessels

- B. Bladder-Type Expansion Tanks:

1. Tank:
 - a. Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature.
 - b. Include drain and air charge taps, floor support and lifting rings, and bolted bulkhead fitting for bladder replacement.
 - c. Factory test with taps fabricated and supports installed and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
 - d. Finish: factory painted corrosion and heat resistant enamel in manufacturer's standard color.
2. Bladder:
 - a. Removable and replaceable water in bag style elastomeric bladder rated for long term oxygen diffusion resistance at the conditions of service.
 - b. Securely sealed into tank via bolted bulkhead fitting with dip tube to separate air charge from system water and maintain required expansion capacity.
3. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats, protective cover plug. Designed to pre-charge pressurized air between bladder and tank. Include extension tee with pressure gage to measure pre charge pressure.

C. Air Separator Assemblies

1. Tangential Air/Solids Separator: Designed, constructed, and ASME stamped for 125 PSIG working pressure, 225 deg. F operating temperature minimum, and sized as noted on Drawings or, if not noted, for minimum single pass solids separation efficiency of 98 percent 200 mesh silica sand in a water suspension.
 - a. Shell: Centrifugal flow solids and air separation design with minimum three times nominal pipe connection diameter and welded steel construction having tangential flanged, grooved, or threaded connections, perforated air collector tube with threaded air separation fitting, sediment collection sump with blow down fitting, and hanger fittings.
 - b. Include automatic blow down system consisting of solenoid or pneumatically operated diaphragm purge valve with fail safe normally closed spring return actuator operation, adjustable programmable timer, isolation valve for servicing and full size blow down piping to approved indirect waste fixture.
 - c. Design Make: "SRS" by Bell & Gossett.

2.9 HYDRONIC STRAINERS

- A. Cast bronze high tensile body for use with copper piping or open system such as condenser/cooling tower water, ASTM A 126 Class B cast iron body for use with closed system steel piping. Provide strainers in size indicated on drawings or same size as connected piping if not specifically indicated, with no higher pressure drop than the design make.
 1. Removable Stainless Steel Screen:
 - a. Strainers 3/4-inch diameter to 3-inches diameter: 1/32-inch perforations.
 - b. Strainers 4-inches diameter to 6 inches diameter: 1/16-inch perforations.
 - c. Strainers 8-inches diameter and larger: 1/8-inch perforations.
 2. Pipe Connections:
 - a. 2-inch pipe and smaller: Screwed or grooved pipe connections.
 - b. 2-1/2-inch pipe and larger: Flanged or grooved pipe connections.
 - c. Soldered connections not permitted.
 3. Working Pressure Ratings: Same as fittings in lines where installed but not less than 125 PSI.
- B. Y-Pattern Strainers:
 1. Tapped strainer blow-down cap, provide with full size capped ball valve.
 2. Threaded pressure taps in strainer body before and after strainer screen for connection to EMCS to alarm on excessive differential pressure.
 3. Similar to products by The Metraflex Company, Spirax Sarco, or Watts.

2.10 HYDRONIC PIPING ACCESSORIES

A. Pipe Sleeves:

1. Sleeve 6-Inches Diameter and Smaller: Schedule 40 galvanized, welded steel pipe, ASTM A53, Grade A.
2. Sleeves Larger than 6-inches: Galvanized sheet metal, 10 gauge, round tube with welded longitudinal joint.
3. Sleeves Installed In Masonry Or Cold Formed Metal Framing/Gypsum Board Construction: Galvanized sheet metal, 20 gauge, round tube with welded longitudinal joint.

B. Escutcheons: Chrome plated, stamped steel, hinged, split-ring escutcheons, with setscrew. Inside diameter closely fits pipe outside diameter or outside diameter of pipe insulation where piping is insulated. Outside diameter completely covers opening in floor, wall, or ceiling.

1. Manufacturer: Manufacturers offering acceptable products include Grinnell.

C. Mechanical Sleeve Seals: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to fill annular space continuously between pipe and sleeve. Connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

1. Manufacturer: Manufacturers offering acceptable products include Thunderline Corp.

2.11 HYDRONIC PIPING SPECIALTIES SPECIFIED ELSEWHERE

- A. Meters and Gauges: as specified in Section 23 05 19.
- B. General Duty Valves: as specified in Section 23 05 23.
- C. Hangers and Supports: as specified in Section 23 05 29.
- D. Flexible Equipment Connectors: as specified in Section 23 05 43.
- E. Pipe Thermal Expansion Compensation: as specified in Section 23 05 43.
- F. Pumps and Pump Specialties: as specified in Section 23 21 23.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Closed Loop Hydronic Piping (heating), aboveground, NPS 2 and smaller:

1. Type L drawn-temper copper tubing with wrought-copper fittings, and soldered, pressure sealed, mechanically grooved, or brazed joints.
2. Schedule 40 steel pipe with welded, threaded, or mechanical grooved fittings and joints. [

- B. Closed Loop Hydronic Piping (heating or dual temperature), aboveground, NPS 2-1/2 and larger:
 - 1. Type L, drawn-temper copper tubing, wrought-copper fittings, and [mechanically grooved or]brazed joints.
 - 2. Schedule 40 steel pipe with welded or mechanical grooved fittings and joints.
- C. Makeup-water piping installed aboveground: Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered, brazed, pressure seal joints.
- D. Air-Conditioning Condensate Gravity Drain Piping:
 - 1. Type M or L, drawn-temper copper tubing, wrought-copper drain fittings, and soldered, brazed, pressure sealed joints.
 - 2. Schedule 40 CPVC plastic pipe, DWV style fittings, and solvent-welded joints.
 - 3. Schedule 40 galvanized steel where subject to damage from non-maintenance personnel.
- E. Air-Conditioning Condensate Pressure-pumped Piping:
 - 1. Type M or L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
 - 2. Schedule 40 CPVC plastic pipe and fittings and solvent-welded joints.
- F. Category IV Boiler Vent Condensate Drain Piping: Schedule 40 CPVC plastic pipe and fittings and solvent-welded joints.
- G. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.
- H. Air-Vent Piping:
 - 1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.
 - 2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.
- I. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.

3.2 PIPING REMOVALS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of existing piping systems to be removed. Remove piping as required for neat installation of the indicated work with no extraneous pipe or fittings remaining and back to the point of continued use where reconnection is not indicated.
- B. Draining:
 - 1. Refer to section 23 01 20 for draining, filling, flushing and cleaning of existing systems.

2. Drain systems completely as required for the contract Work so as to avoid cross contamination of system's heat transfer fluids.
3. Protect Owner's belongings from damage during draining and removals.
4. Install additional drains if necessary to completely drain system. Note that drain valves are required on all new piping low points.
5. Legally dispose of all drainage unless specifically shown on the drawings to be re-used.

3.3 PIPING INSTALLATIONS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated piping locations and arrangements were used to size piping, calculate friction loss, expansion compensation, pump sizing, fill volume, and other design considerations. Install piping generally as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Select system components with pressure rating equal to or greater than system operating pressure.
- C. Install piping in concealed locations except in equipment rooms and service areas, unless otherwise indicated on drawings: install in walls, pipe chases, utility spaces, above ceilings, etc.
- D. Install piping orthogonal to building walls as possible within constraints required for sloped drainage, non-orthogonal building construction, etc. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install fittings for changes in direction and branch connections, unless otherwise specified.
 1. Branches two or more sizes smaller than main may be weld-o-let welded to steel pipe and brazed to copper using listed mechanically formed outlets similar to "T-drill".
 2. Minor offsets in copper fin-tube piping required to segment enclosures along curved exterior walls may be created by smooth bends in annealed type L or K copper tube. Do not bend fin element.
 3. Mitered elbows, "shaped" nipples, and job fabricated reductions are not acceptable.
 4. Where corridors or other general construction meets at angles other than standard pipe fitting angles, provide custom bend angle elbows to match general construction and maintain piping orthogonal to building.
- F. Install piping so as to provide for positive drainage and air elimination.
 1. Install straight piping free of sags and bends. Do not install bent piping – remove from site.
 2. Install gravity drain lines at uniform slope down in direction of flow. Maintain maximum slope feasible up to one quarter inch rise per foot of run, but not less than 1% (approximately one eighth inch per foot). Where height restrictions do not allow for minimum required slope, provide for pumped condensate removal as shown.

3. Install pressurized pumped flow piping at a uniform grade of 0.2 percent upward in direction of flow or at otherwise indicated slopes.
 4. Avoid local high and low points where possible.
 5. Install branch connections out the top of mains to serve equipment above mains, and out the bottom of mains to serve equipment below, or otherwise as required to provide drainage and venting with a minimum of drain and vent fittings.
 6. Provide eccentric pipe size reducers and increasers, installed so as to allow for both positive drainage and air elimination. In general, where piping is sloped up in direction of flow, reduce pipe sizes with level side up and increase pipe sizes with level side down.
- G. Install piping allowing for proper servicing of hydronic systems.
1. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
 2. Install piping and specialties with sufficient clearance to allow application of specified insulation.
 3. Install valves with sufficient clearance and orientation to permit both ease of operation and servicing.
 4. Install dis-assemble able unions, flanges, or mechanical joints on equipment side of isolation valve, as required to remove and service all serviceable components without system drain-down or cutting piping. Install unions and flanges in piping.
 - a. Provide unions for NPS 2 and smaller, flanges for NPS 2-1/2" and larger.
 - b. Install adjacent to control valves, at final connections of equipment, as required to adjust threaded pipe joints after fixed (non-rotatable) joints are made, and elsewhere as indicated.
 - c. Install out of the line of coil pull, tube bundle removal access space, etc.
 - d. Install so sensor wires, thermometers, gauges, etc., need not be rotated, removed, or disconnected to service equipment.
 - e. Install within two feet of control valves with no elbows between valve and union as required for ease of replacement.
 - f. One dis-assemble able fitting may be used for two components (ex., both control valve and equipment service) if they are separated by no soldered, brazed, or welded elbows and no more than three feet of pipe.
- H. Identify piping as specified in Section 23 05 53 - Identification for HVAC Components.
- I. Install sleeves for piping penetrations of walls, ceilings, and floors.

- J. Install escutcheons for exposed piping penetrations of walls, ceilings, and floors.
- K. Install sleeve seals for piping penetrations of concrete walls and slabs.

3.4 PIPE JOINT CONSTRUCTION

A. General Pipe Joint Construction:

1. Cut all pipe ends square.
2. Ream ends of pipes and tubes removing burrs past original pipe wall to restore full pipe ID.
3. Remove scale, slag, dirt, and debris from both inside and outside of piping and fittings before assembly.
4. Remake leaking joints using new materials.

B. Threaded Joints:

1. Provide threaded pipe ends in conformance with ANSI B1.20.1, tapered pipe thread standards
2. Cut threads full and clean using sharp cutting oil flooded dies.
3. Note internal length of threads in fittings or valve ends and proximity of internal seat or wall to determine pipe threading and align threads at point of assembly.
4. Apply appropriate tape or thread compound to the external pipe threads (except where dry seal threading is specified) and assemble joint "wrench-tight" with paired wrenches, one wrench on adjacent pipe and one wrench on valve end where pipe is threaded.
5. Damaged Threads: Do not use pipe or fittings with torn, corroded or damaged threads.
6. Do not use portions of pipe where weld opens during cutting or threading operations.

C. Soldered Joints:

1. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook,"
2. Square cut tubing to correct length required to fill sockets.
3. Ream ends and clean surfaces of oils, grease, and oxidation to bright finish with fine sand cloth, cleaning pads, or special wire brush.
4. Apply thin film of solder flux to both surfaces to be joined. Do not clean, flux and assemble joint more than 3 hours before soldering, and do not use acid core, paste type solder, or solder flux combinations.
5. Remove heat-sensitive portions of components prior to soldering. Provide wet rag strip heat sink wrapped around stem and seat of valves and protect all components for soldering heat damage. Replace any components with any evidence of heat damage.

6. Heat joint uniformly and rapidly and fill completely with solder while minimizing external and internal over-soldered dripping.
7. Disassemble joints for inspection of solder penetration as directed. Remake faulty joints at no additional cost.

D. Brazed Joints:

1. Comply with the procedures contained in AWS "Brazing Manual", using qualified processes and brazing operators according to Part 1 "Quality Assurance" Article.
2. Remove stems, seats, and packing of valves and accessible internal parts at piping specialties before brazing.
3. Fill the pipe and fittings with an inert gas (i.e. nitrogen or carbon dioxide) during brazing to prevent formation of scale.
4. Heat joints using oxyacetylene torch. Heat to proper and uniform temperature.
5. Completely fill sockets with braze materials, and make neat fillets on butt joints.

E. Welded Joints:

1. Comply with the requirements of ASME Code B31.9 - "Building Services Piping", ASME B16.25, and AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
2. Machine-chamfer all pipe ends for butt welded joints.
3. Remove cutting beads and do not allow welding beads to form.

F. Grooved Joints:

1. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness.
2. Assemble joints with coupling and gasket, lubricant, and bolts in accordance with fitting manufacturers written instructions.
3. Install rigid couplings for normal straight pipe runs.
4. Install flexible type couplings for branch take-offs, elbows, as part of the thermal expansion compensation system design, as vibration isolation flexible connections where specified for that, and as otherwise directed.

G. Flanged Joints:

1. Select appropriate gasket material, size, type, and thickness for service application.
2. Install gasket concentrically positioned, and dielectric kits if flanges join dis-similar piping materials.
3. Align flanged surfaces parallel.
4. Use suitable lubricants on bolt threads.

5. Make initial contact of flanges and gaskets flat and parallel with bolts only finger tight, then tighten bolts using alternating sequential pattern, gradually and uniformly to full torque using torque wrench.

H. Plastic Piping Solvent-Welded Joints:

1. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
2. Square cut and ream pipe ends to correct length.
3. Clean exterior of pipe and interior of fittings with rags and water and dry thoroughly before solvent cleaning with primer.
4. Check dry fit for interference fit to ensure pipe can be pushed at least 1/3 of way into fitting by hand. Ensure pipe that "bottoms" is snug.
5. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
6. Use only approved cement and primer suitable for types of pipes and fittings used and suitable for intended service, including temperature, pressure pipe size, and fluids served. Use only fresh cement; do not use thickened, lumpy, or "jelly like" cement.
7. Clean pipe and fitting with cement manufacturer's primer or cleaner. Use contrasting color primer and cement
8. Stir or shake cement before use. Apply thin coat of cement in socket, then evenly coat pipe end to socket depth. Avoid puddling, especially on thin walled pipe.
9. Assemble joint by twisting pipe 1/4 turn while pushing to full socket depth. Provide adequate anchorage and leverage to assemble pipe to full socket depth of fittings; hand pressure is inadequate and not acceptable for larger sizes. Hold pressure for 30 seconds or as required avoiding push out. Allow additional time for cement to set in colder weather to ensure cement film cures without blisters. Wipe off excess cement between socket and pipe with clean, dry rag.
10. Keep cement cool in hot weather and work as quickly as possible to avoid cement setting up before joint is assembled. Keep lid on cements, cleaner, and primers when not in use. Do not mix cleaner or primer with cement.
11. Use 3/4-inch dauber on small diameter pipes, 1-1/2 inch dauber up through 3 inch pipe, and natural bristle brush, swab, or roller 1/2 pipe diameter on pipes 4 inch and up.

I. Mechanically Formed, Copper-Tube-Outlet Joints:

1. Use manufacturer-recommended tools and procedure.
2. Ensure alignment dimples are properly oriented and visible after brazing.
3. Braze joints using approved procedures and brazers.

J. Pressure-Sealed Joints:

1. Make copper and copper alloy press connections in accordance with the manufacturer's installation instructions.
2. Fully insert the tubing into the fitting with a visible mark on the tubing showing proper insertion. Align the tubing as required.
3. Check the fitting alignment against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. Leave insertion marks visible on pipe after assembly.
4. Press the joints using the tool(s) approved by the joint manufacturer in a manner to assure tubing remains properly aligned.
5. Remove and replace misaligned, kinked, or otherwise damaged tubing installations. .

3.5 HYDRONIC SPECIALTIES INSTALLATION

- A. At each system local or global low point, both in piping and heat transfer elements, and as required for complete system drainage, install drain consisting of a tee fitting and drain valve as described in Section 23 05 23 – General Duty Valves for HVAC Piping.
- B. At each system local or global high point, both in piping and heat transfer elements, at the end of each horizontal run before a drop in elevation, and elsewhere as required for complete and serviceable venting of system air, install vent consisting of a tee fitting and air vent as described in Section 23 05 23 – General Duty Valves for HVAC Piping.
- C. Install strainers on inlet side of each pump, pressure-reducing valve, and elsewhere as indicated. Install NPS 3/4 ball valve (match size of strainer blowoff connection for strainers with smaller blowoff tappings) with hose thread connection and brass cap in blowdown connection of strainers.
- D. Install AC condensate termination strainers where AC condensate drips to any exterior point of indirect waste disposal.
- E. Install expansion compensation as shown on drawings and in all straight piping runs eighty (80) feet long and longer, at least one (1) expansion loop per one hundred twenty (120) feet of straight run. Install anchors and pipe alignment guides for each expansion loop. Install expansion compensation, anchors, and pipe alignment guides as specified in Sections 23 05 29 – Hangers and Supports for HVAC Components and Section 23 05 43 – Mechanical Vibration and Movement Control.
- F. Install all components of Energy Management and Control System (EMCS) into hydronic systems as required for complete EMCS installation and as required by this section maintaining integrity of hydronic systems. Coordinate all locations and quantities with contractor responsible for the EMCS – refer to Section 23 09 00 – Instrumentation and Control for HVAC.
 1. Install control valves in accessible locations close to connected equipment or as otherwise shown, with dis-assemble able connections.
 2. Install wells for pressure, temperature, and other sensors as shown on details and as called for by the sequence of operations.

- G. Install ports and wells for pressure gages and thermometers at coil inlet and outlet connections according to Division 23 Section "Meters and Gages for HVAC Piping."
- H. Install pressure / temperature test ports (P/T plugs) at the supply and return of every heat transfer element, and as otherwise called for on drawings.
- I. Install piping to pumps. Details of near pump piping are specified in Section 23 21 23 – Hydronic Pumps
- J. Install piping from boiler air outlet and air separator to expansion tank with a 2 percent upward slope toward tank.
- K. Install air separator where shown, in general in high temperature low pressure location similar to between boiler outlet and pump suction. Install blowdown piping full size of air separator drain connection, with full-port ball valve; extend full size to point of collection.
- L. Install vertical expansion tanks on concrete housekeeping pad on the floor. Pre-charge air pressure in tank to scheduled pressure or if not scheduled to pressure directed by engineer. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system Project requirements.

3.6 VALVE APPLICATIONS

- A. Install General Duty Valves (isolation valves, check valves, balancing valves, air vent valves, and drain valves) as specified in Section 23 05 23 – General Duty Valves for HVAC Piping.
- B. Install safety valves on each boiler, and elsewhere as required by ASME Boiler and Pressure Vessel Code, on the pressure vessel side of any equipment isolation valves. Pipe safety valve discharge independently to nearest floor drain full size without valves or as otherwise indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

3.7 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor devices are specified in Section 23 05 29 "Hangers and Supports for HVAC Components". Comply with the following requirements for maximum spacing of supports.
- B. Sound, vibration, and movement control is specified in Section 23 05 43 – Mechanical Vibration and Movement Control.

3.8 TERMINAL EQUIPMENT CONNECTIONS

- A. Size supply and return piping run-outs to equipment connections same as shown on the drawings. Where connecting to existing piping run-outs, use same size as existing unless shown otherwise. Transition to equipment connection size close to equipment. If equipment connection size is smaller than piping shown, transition to piping size shown immediately with no elbows (except reducer elbows) or other fittings closer to the equipment than the required transition fitting.

- B. Provide for thermal movement of piping adjacent to terminal equipment, using flexible hose connections, swing joints, etc. Refer to Section 23 05 43 – Mechanical Vibration and Movement Control for details.

3.9 CHEMICAL TREATMENT

- A. Refer to Section 23 01 20 – Hydronic Systems Cleaning and Water Treatment.

3.10 FIELD QUALITY CONTROL

- A. Prepare hydronic piping according to ASME B31.9 and as follows:
 - 1. Clean the interior of all piping prior to installation in systems.
 - 2. Leave joints, including welds, uninsulated and exposed for examination during test.
 - 3. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
 - 4. Fill and flush hydronic piping systems with clean potable water until system is clean, vent all air from systems then remove and clean or replace all affected strainer screens repeatedly until no further debris is captured. Re-fill and re-vent system.
 - 5. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
 - 6. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
- B. Perform the following tests on hydronic piping:
 - 1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
 - 2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
 - 3. Isolate expansion tanks and determine that hydronic system is full of water.
 - 4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."

5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
 6. Prepare written report of testing.
- C. Perform the following before operating the system:
1. Open manual valves fully.
 2. Inspect pumps for proper rotation.
 3. Set makeup pressure-reducing valves for required system pressure.
 4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
 5. Set temperature controls so all coils are calling for full flow.
 6. Inspect and set operating temperatures of hydronic equipment, such as boilers to specified values.
 7. Verify lubrication of motors and bearings.

END OF SECTION 23 21 13

SECTION 23 21 23 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Separately coupled, base-mounted, end-suction centrifugal pumps.
 - 2. Automatic condensate pump units.
 - 3. Pump Accessories.

1.3 DEFINITIONS

- A. Buna-N: Nitrile rubber.
- B. EPT: Ethylene propylene terpolymer.
- C. SiC: Silicon Carbide.

1.4 SUBMITTALS

- A. Action Submittals:
 - 1. Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves. Demonstrate equal or better performance to basis of design equipment in terms of construction, efficiency, dimensions, system connections, etc.
 - 2. Shop Drawings: Show pump layout and connections. Include dimensioned setting drawings for installing foundation and anchor bolts and other anchorages.
 - 3. Motor Data: Motor horsepower, electrical characteristics, and construction details demonstrating compliance with requirements.
 - 4. Machinist's qualifications.
 - 5. Pump alignment report.

B. Closeout Submittals:

1. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain hydronic pumps through one source from a single manufacturer.
- B. Machinist Qualifications: Pump alignment machinist shall be a mechanic specializing in machine alignment and set-up with demonstrable training and experience achieving the tolerances specified, employed independently of the pump manufacturer or selling representative. Include specifications and calibration for alignment equipment proposed for use on this project's alignment work.
- C. Product Options: Drawings indicate size, profiles, and dimensional requirements of hydronic pumps and are based on the specific system indicated. Refer to specification Section 01 60 00 "Product Requirements."
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.
- B. Store pumps in dry location.
- C. Retain protective covers for flanges and protective coatings during storage.
- D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.
- E. Comply with pump manufacturer's written rigging instructions.

1.7 COORDINATION

- A. Coordinate size and location of concrete bases.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Mechanical Seals: One extra mechanical seal for each pump.

PART 2 - PRODUCTS

2.1 GENERAL PUMP REQUIREMENTS

- A. Materials: Provide materials suitable for fluid, pressures, temperatures, and conditions for each application.
- B. Performance: Minimum of design make throughout operating ranges, including capacity, head, NPSHR, and efficiency.
- C. Configuration and Characteristics
 - 1. Provide dynamically balanced pumps for all applications.
 - 2. Provide tapped connections for pressure gauges at inlet and outlet, and vent and drain taps at high and low points.
 - 3. Arrange for independent machinist to align each base mounted pump.
- D. Motors:
 - 1. Capable of running continuously without undue noise, heat, sparking, or overloading.
 - 2. Extra quiet operating, EPAC “Plus” premium efficiencies for base-mounted pumps.
 - 3. Sized as non-overloading at 60 Hz with pump operating at any point on the impeller curve.
 - 4. All three phase motors for use with variable speed drives shall be special application, inverter duty design of cast iron TEFC construction. Inverter duty design features shall include an inverter grade Class F insulation system meeting NEMA MG-1, Part 31, Class F thermostats, one per phase, premium efficiency design. Motors shall meet all other requirements of this document, the equipment manufacturer, and the adjustable speed drive manufacturer, and be rated for this service with the drive and voltage intended.
- E. Pump Seals: Rated for continuous service for the fluid, temperature, conditions, and pressure of the required service. If conditions are not scheduled, verify in field before submitting Bid.
 - 1. SiC/SiC/EPR Mechanical Seals: Silicon carbide rotating and stationary primary faces, bellows of EPT, EPDM, or other elastomer rated for the service, springs and other wetted seal parts of stainless steel.
 - a. Provide one spare seal for each mechanically sealed pump, same type as specified, turned over in sealed manufacturer’s packaging to Owner. Include receipt with seal part numbers and contact information for obtaining additional seals in O&M manual.
 - 2. Filters: Provide a filtered flush for seals.
 - a. Cartridge Filters For Closed Systems: Cartridge type seal flush filters, factory installed and capable of 98 percent removal of particles 25 microns and larger. Includes in-line sight flow indicator and isolation valves as required to facilitate filter changing without system shutdown.

- b. Quantity: Provide minimum 3 filter cartridges for each system; minimum 1 for temporary use during system startup and commissioning (change to new filter as required during temporary service before final completion), change to new cartridge immediately following acceptance of Substantial Completion, and provide one spare filter cartridge turned over to Owner for each filtered flush system. Include receipt with filter part numbers and contact information for obtaining additional filters in O&M manual.

2.2 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

- A. Manufacturers: Basis of design is as scheduled. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
 - 1. Series 4030 by Armstrong Pumps Inc.
 - 2. Series e-1510 by ITT Corporation; Bell & Gossett.
 - 3. Series LF by PACO – Grundfos CBS.
- B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump designed for base mounting, with pump and motor shafts horizontal. Rate pump for 125-psig minimum working pressure and a continuous water temperature of 225 deg F.
- C. Pump Construction:
 - 1. Casing: Single stage, radially split allowing true back pull out, grade 30 cast iron body, bronze fitted construction, replaceable bronze or stainless steel wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and flanged connections. Provide integrally cast and machined mounting feet with through bolt holes to support and secure the casing and attached piping allowing removal and replacement of seals and impeller without disconnecting piping or requiring the realignment of pump and motor shafts.
 - 2. Impeller: ASTM B 584 bronze or stainless steel, precision vacuum cast, closed design with pressure balancing internal flush holes, precision machined and finished on all surfaces removing burrs and casting irregularities resulting in smooth hydraulically efficient surfaces, trimmed as required to meet capacity scheduled, dynamically balanced after trimming to ANSI/HI 9.6.4 grade 2.5, secured to shaft with key and locking stainless steel cap screw.
 - 3. Pump Shaft: Steel, with copper-alloy shaft sleeve, or stainless steel.
 - 4. Pump Bearings: Grease-lubricated ball bearings contained in cast-iron housing with grease fittings.
- D. Shaft Coupling: Molded rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor. Include EPDM coupling sleeve.

- E. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.
- F. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels, angles, and plates. Fabricate to mount pump casing, coupling guard, and motor. Include provisions to facilitate solid grouting.

2.3 AUTOMATIC CONDENSATE PUMP UNITS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Beckett Corporation.
 - 2. Hartell Pumps Div.; Milton Roy Co.
 - 3. Little Giant Pump Co.
- B. Description: Packaged units with corrosion-resistant pump, plastic tank with cover, and automatic controls. Include factory- or field-installed check valve, safety shut-off float and low voltage switch, mounting bracket, and a 72-inch-minimum, electrical power cord, designed to automatically pump out sump through float switch and equipped with safety shut-off to interrupt the operation of the AC unit on high water condition.

2.4 PUMP ACCESSORIES

- A. Pump Suction Diffuser:
 - 1. Angle pattern pump-inlet fitting.
 - 2. Cast-iron body and end cap with integral size reduction from system piping to pump suction size if difference exists.
 - 3. Bronze fine startup screen and bronze or stainless-steel permanent strainers.
 - 4. Bronze or stainless-steel straightening vanes.
 - 5. Drain plug with magnetic insert; and factory-fabricated support.
 - 6. 175-psig pressure rating.
- B. Provide pump discharge valve for each pump as specified in Section 23 05 23 – General Duty Valves for HVAC Piping.
- C. Provide concrete bases for all base mounted pumps. Refer to Section 23 05 00 - Common Work Results for HVAC and Division 03 for details of required concrete bases.
- D. Provide flexible equipment connections for all base mounted pumps. Refer to Section 23 05 43 – Mechanical Vibration and Movement Control for details.
- E. Provide a pressure gauge for each pump as specified and as detailed. Refer to Section 23 05 19 – Meters and Gauges for HVAC Systems for details.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Examine conditions under which pumps are to be installed and notify Architect in writing of any conditions detrimental to proper and timely installation. Correct unsatisfactory conditions as required, and do not proceed with installation until unsatisfactory conditions have been corrected in an acceptable manner.
 - 1. Insure equipment foundations and anchor-bolt locations are in compliance with installation tolerances and other conditions affecting performance of work and service access.
 - 2. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
 - 3. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.
- B. Beginning installation constitutes Contractor's acceptance of substrates and conditions required to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied.

3.2 PUMP INSTALLATION

- A. Install in accordance with manufacturer's specific recommendations and in accordance with all related sections of technical specifications. Obtain manufacturer's instructions and follow them, using the instructions written below as a minimum standard for comparison.
- B. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.
- C. Support piping adjacent to pump connections independently of pumps such that load from piping is not transmitted through pumps.
 - 1. Support piping adjacent to inline pumps securely as required to support pumps from piping. Support with piping supports as specified, with continuous-thread hanger rods and vibration isolators of size required to support weight of in-line pumps.
- D. Base mounted pump mounting: Install all base mounted pumps as follows in the sequence written.
 - 1. Install concrete bases of proper dimensions and configuration as specified for pumps and controllers.
 - 2. Install pumps on a concrete base as outlined in Division 23 Section "Common Work Results for HVAC".
 - a. Set adjustable internally threaded concrete inserts at appropriate bolt-down locations before pouring equipment bases.

- b. Be responsible for accurate size of base and exact location of mounting bolts.
 - c. Disconnect coupling before setting. Do not reconnect couplings until alignment procedure is complete.
- 3. Fasten all pump bases to concrete bases with foundation bolts.
 - a. Insure that the pump suction and discharge flanges are orthogonal to the structural base of the pump without shimming. Securely tighten all pump volute mounting bolts to the pump base, and use the discharge flange surface for leveling and the pump base rails for lateral alignment of the pump to the system. Align the motor to the pump after the pump base is properly grouted.
 - b. Properly level each pump base. Use metal wedges and/or shims set on both sides of every bolt. Make a minimum gap of three times the grout aggregate size or 1/2-inch, whichever is greater.
 - c. Securely tighten all pump base bolts.
 - d. Remove projecting parts of wedges and shims.
- 4. Properly grout the complete base.
 - a. Fill all pump bases with grout conforming to CRD-C-621-80 "Corps of Engineers Specification for Non-Shrink Grout", and as detailed in Division 03.
 - b. Fill base through grouting holes provided in baseplate.
 - c. After grout has hardened for a minimum of seven (7) days, re-tighten all pump foundation bolts and only then align pumps.
- 5. Align pumps.
 - a. Engage an INDEPENDENT MACHINIST to align and verify alignment of each pump and to certify and deliver report on measured alignment tolerances achieved.
 - b. Submit machinist's name, business address, and qualifications.
 - c. Do not pipe or start up any pump until after alignment is complete and correct. Do not align pumps until pumps are installed on concrete bases and grouted as specified above.
 - d. Align all pumps by moving the motor with respect to the fixed impeller housing.
 - e. If the impeller housing flanges are substantially out of level and/or alignment with respect to the system, bring them into alignment using a minimum of shims and an appropriate thinset grout before aligning the motor.
 - f. Motor shaft to impeller shaft alignment tolerances:
 - 1) Align to the stricter of:
 - a) Manufacturer's printed alignment tolerances.
 - b) 0.004-inch total indicator reading (TIR) radial and 0.004-inch TIR angular at 3-inch radius.

- g. After pumps are aligned, install dowels to prevent shifting and properly re-install coupling and guard.
 - h. Within two business days of alignment, submit a written report certified by machinist guaranteeing that alignment is complete and stating the alignment tolerances required and obtained.
 - i. Contractor is responsible for trouble resulting from poor pump alignment.
6. Connect the pipe system to the pumps:
- a. Install inlet suction diffusers for all end suction pumps with support legs adjusted to prevent any strain on the pump inlet.
 - b. Install pipeline flexible connectors at each suction (diffuser) and discharge port of each pump. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
 - c. Pipe as required by the detail pump connection drawings, including all valves, fittings, gauges, and controls.
7. Three operating months later, have the machinist recheck all alignments, recording data, correcting any changes, and reporting in writing to the Contractor and Architect all data and offering an interpretation of the cause and significance of the changes.
8. Submit letter attesting to completion of alignment.
- E. Adjust GPM of each pump to capacity called for during balancing.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect piping to pumps. Install isolation valves on both suction and discharge that are same size as piping shown approaching the pumps, prior to any size change required at pump connections.
- D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
- E. Install triple-duty valve on discharge side of pumps.
- F. Install suction diffuser on suction side of all base mounted pumps.
 - 1. Install suction diffuser on suction side of in-line pumps where a minimum of five pipe diameters straight line size pipe cannot be maintained at and in line with pump inlet.
- G. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

- H. Install pressure gauges on pumps as specified.
- I. Install electrical connections for power, controls, and devices in accordance with Section 23 29 00 – Variable Speed Motor Controllers, Section 23 05 13 – Common Electrical Requirements for HVAC, and Division 26.

3.4 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Check piping connections for tightness.
 - 3. Clean strainers on suction piping.
 - 4. Perform the following startup checks for each pump before starting:
 - a. Verify bearing lubrication.
 - b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
 - c. Verify that pump is rotating in the correct direction.
 - 5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
 - 6. Start motor.
 - 7. Open discharge valve slowly.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps. Refer to specification Section 01 79 00 - "Demonstration and Training."

END OF SECTION 23 21 23

SECTION 23 23 00 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes refrigerant piping used for air-conditioning applications.

1.3 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-32 or equivalent:
 - 1. Suction Lines for Air-Conditioning Applications: 300 psig .
 - 2. Suction Lines for Heat-Pump Applications: 535 psig.
 - 3. Hot-Gas and Liquid Lines: 535 psig.

1.4 SUBMITTALS, GENERAL

- A. General: Submit all action submittals and informational submittals required by this Section concurrently.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of refrigerant, piping, valve, and refrigerant piping specialty proposed. Include pressure drop, based on manufacturer's test data, for the following:
 - 1. Refrigerant.
 - 2. Thermostatic expansion valves.
 - 3. Solenoid valves.
 - 4. Hot-gas bypass valves.
 - 5. Filter dryers.
 - 6. Strainers.
 - 7. Pressure-regulating valves.
- B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.
 - 1. Shop Drawing Scale: 1/4 inch equals 1 foot .

2. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

1.6 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.7 CLOSEOUT SUBMITTALS

- A. Field quality-control test reports.
- B. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.8 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
- C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.9 PRODUCT STORAGE AND HANDLING

- A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

1.10 COORDINATION

- A. Coordinate size and location of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B 88, Type K or L, ASTM B 280, Type ACR.
- B. Wrought-Copper Fittings: ASME B16.22.
- C. Wrought-Copper Unions: ASME B16.22.
- D. Brazing Filler Metals: AWS A5.8.

E. Flexible Connectors:

1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
2. End Connections: Socket ends.
3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
4. Pressure Rating: Factory test at minimum 500 psig.
5. Maximum Operating Temperature: 250 deg F.

2.2 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:

1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
3. Operator: Rising stem and hand wheel.
4. Seat: Nylon.
5. End Connections: Socket, union, or flanged.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.

B. Check Valves:

1. Body: Forged brass, or cast bronze; globe pattern.
2. Bonnet: Forged brass, or cast bronze; or brass hex plug.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
6. End Connections: Socket, union, threaded, or flanged.
7. Maximum Opening Pressure: 0.50 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 275 deg F.

C. Service Valves:

1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig.

D. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.

1. Body and Bonnet: Plated steel.
2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Threaded.

5. Electrical: Molded, watertight, replaceable AC coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and voltage as required.
 6. Working Pressure Rating: 400 psig.
 7. Maximum Operating Temperature: 240 deg F.
- E. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
 2. Piston, Closing Spring, and Seat Insert: Stainless steel.
 3. Seat Disc: Polytetrafluoroethylene.
 4. End Connections: Threaded.
 5. Working Pressure Rating: 400 psig.
 6. Maximum Operating Temperature: 240 deg F.
- F. Thermostatic Expansion Valves: Comply with ARI 750.
1. Body, Bonnet, and Seal Cap: Forged brass or steel.
 2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
 3. Packing and Gaskets: Non-asbestos.
 4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
 5. Suction Temperature: 40 deg F .
 6. Superheat: Adjustable
 7. Reverse-flow option (for heat-pump applications).
 8. End Connections: Socket, flare, or threaded union.
 9. Working Pressure Rating: 700 psig .
- G. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.
1. Body, Bonnet, and Seal Cap: Ductile iron or steel.
 2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
 3. Packing and Gaskets: Non-asbestos.
 4. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
 5. Seat: Polytetrafluoroethylene.
 6. Equalizer: Internal.
 7. Electrical: Molded, watertight, replaceable AC coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and voltage as required.
 8. End Connections: Socket.
 9. Throttling Range: Maximum 5 psig.
 10. Working Pressure Rating: 500 psig.
 11. Maximum Operating Temperature: 240 deg F.
 12. Include manual operator.
- H. Straight-Type Strainers:
1. Body: Welded steel with corrosion-resistant coating.
 2. Screen: 100-mesh stainless steel.
 3. End Connections: Socket or flare.
 4. Working Pressure Rating: 500 psig.
 5. Maximum Operating Temperature: 275 deg F .

I. Angle-Type Strainers:

1. Body: Forged brass or cast bronze.
2. Drain Plug: Brass hex plug.
3. Screen: 100-mesh monel.
4. End Connections: Socket or flare.
5. Working Pressure Rating: 500 psig.
6. Maximum Operating Temperature: 275 deg F.

J. Moisture/Liquid Indicators:

1. Body: Forged brass.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in ppm.
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 240 deg F.

K. Replaceable-Core Filter Dryers: Comply with ARI 730.

1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig .
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 240 deg F.

L. Receivers: Comply with ARI 495.

1. Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
2. Comply with UL 207; listed and labeled by an NRTL.
3. Body: Welded steel with corrosion-resistant coating.
4. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
5. End Connections: Socket or threaded.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.

M. Liquid Accumulators: Comply with ARI 495.

1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or threaded.
3. Working Pressure Rating: 500 psig.
4. Maximum Operating Temperature: 275 deg F.

2.3 REFRIGERANTS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Atofina Chemicals, Inc.
 - 2. DuPont Company; Fluorochemicals Div.
 - 3. Honeywell, Inc.; Genetron Refrigerants.
 - 4. INEOS Fluor Americas LLC.
- B. ASHRAE 34, R-32: Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-32

- A. Suction Lines NPS 1-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.
- B. Suction Lines NPS 3-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR,L, drawn-temper tubing and wrought-copper fittings with brazed joints.
- C. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR, L, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
- D. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications:
 - 1. NPS 5/8 and Smaller: Copper, Type ACR or L, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
 - 2. NPS 3/4 to NPS 1 and Smaller: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
 - 3. NPS 1-1/4 and Smaller: Copper, Type ACR. K or L, drawn-temper tubing and wrought-copper fittings with brazed joints.
 - 4. NPS 1-1/2 to NPS 2: Copper, Type ACR, K or L, drawn-temper tubing and wrought-copper fittings with brazed joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

- A. Install diaphragm packless valves in suction and discharge lines of compressor.
- B. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.
- C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.
- D. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.

- E. Install a full-sized, three-valve bypass around filter dryers.
- F. Install thermostatic expansion valves as close as possible to distributors on evaporators.
 - 1. Install valve so diaphragm case is warmer than bulb.
 - 2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
 - 3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
- G. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
- H. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:
 - 1. Thermostatic expansion valves.
 - 2. Hot-gas bypass valves.
 - 3. Compressor.
- I. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor, if not provided as part of installed equipment manufacturer.
- J. Install receivers sized to accommodate pump-down charge.
- K. Install flexible connectors at compressors.

3.3 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
- B. Install refrigerant piping according to ASHRAE 15.
- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping adjacent to machines to allow service and maintenance.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.

- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Refer to Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls" shown on drawings for solenoid valve controllers, control wiring, and sequence of operation.
- K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Division 08 Section "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.
- M. Install refrigerant piping in protective conduit where installed belowground. Provide for drainage and liquid accumulation.
- N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- O. Slope refrigerant piping as follows:
 - 1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
 - 2. Install horizontal suction lines with a uniform slope downward to compressor.
 - 3. Install traps and double risers to entrain oil in vertical runs.
 - 4. Liquid lines may be installed level.
- P. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- Q. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- R. Identify refrigerant piping and valves according to Division 23 Section "Identification for HVAC Piping and Equipment."
- S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23.
- T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 23.
- U. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.4 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
 - 1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
 - 2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 - 1. Comply with ASME B31.5, Chapter VI.
 - 2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
 - 3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
 - a. Fill system with nitrogen to the required test pressure.
 - b. System shall maintain test pressure at the manifold gage throughout duration of test.
 - c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
 - d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.6 SYSTEM CHARGING

- A. Charge system using the following procedures:
 - 1. Install core in filter dryers after leak test but before evacuation.
 - 2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
 - 3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
 - 4. Charge system with a new filter-dryer core in charging line.

3.7 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

- C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
 - 1. Open shutoff valves in condenser water circuit.
 - 2. Verify that compressor oil level is correct.
 - 3. Open compressor suction and discharge valves.
 - 4. Open refrigerant valves except bypass valves that are used for other purposes.
 - 5. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 23 23 00

SECTION 23 29 00 – VARIABLE FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes separately enclosed, pre-assembled, combination VFCs (variously referred to as VFC, ASD, VSD, or VFD), rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.
 - 1. “Micro-drive”: VFC for use with motors of 1HP or less (unless scheduled otherwise), capable of and designed for driving three phase motors with single phase or three phase input line power, as required.
 - 2. “General Purpose” VFC for use with motors > 1HP (unless scheduled otherwise).

1.3 DEFINITIONS

- A. ASD: Adjustable Speed Drive, same as VFC.
- B. BAS: Building automation system
- C. CPT: Control power transformer.
- D. EMI: Electromagnetic interference.
- E. EMC: Electromagnetic Compliance.
- F. IGBT: Insulated-gate bipolar transistor.
- G. LAN: Local area network.
- H. LED: Light-emitting diode.
- I. MCP: Motor-circuit protector.
- J. NC: Normally closed.
- K. NO: Normally open.
- L. OCPD: Overcurrent protective device.
- M. Output: Variable frequency output power and wiring between the VFC and the load (motor).
- N. PCC: Point of common coupling.
- O. PID: Control action, proportional plus integral plus derivative.
- P. Power: source electrical power input wiring to the VFC.
- Q. PWM: Pulse-width modulated.
- R. RFI: Radio-frequency interference.
- S. Signal: Remote generated electrical signal causing controlled variation in VFC output.
- T. TDD: Total demand (harmonic current) distortion.
- U. THD(V): Total harmonic voltage demand.
- V. VFC: Variable-frequency motor controller.
- W. VFD: Variable Frequency Drive, same as VFC.
- X. VSD: Variable Speed Drive, same as VFC.

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: VFCs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
- B. Design and Performance Requirements
 - 1. Designed to convert 60 Hz input power to adjustable frequency output power with constant and/or variable volts/Hz ratio output power. Output frequency and drive voltage adjustable determined by design parameters of driven motor.
 - 2. Capable of operating any standard squirrel cage induction motor with load rating within capacity of adjustable speed drive. Allows substitution of standard motor in field without requiring modification of adjustable speed drive.
 - 3. Designed and manufactured in accordance with applicable current NEMA and IEEE recommendations and designed for installation per NEC. Includes equipment with UL and CSA approval as applicable.
 - 4. Suitable for installation in altitudes up to 3300 ft with ambient temperature range from 32 deg F to 104 deg F
 - 5. Designed with dedicated variable torque design for specified use with centrifugal loads.
 - 6. "Micro-Drive" includes all of above features plus:
 - a. Capable of and designed for converting single-phase input to three phase output.
 - 7. "General Purpose" Drive includes all of above features plus:
 - a. Suitable to serve as starter and disconnect.
 - b. Designed with surface-mount construction regulator circuits.
 - c. Provided with UL-listed electrical components in basic ASD, including but not limited to contactors, overload relays, pushbuttons, pilot devices, and other control devices.

1.5 SUBMITTALS

- A. Procedural Requirements: Comply with requirements of SECTION 01 33 00 - Submittals and as modified below.
- B. Product Data: For each type and rating of VFC indicated. Include features, performance, electrical ratings, operating characteristics, shipping and operating weights, and furnished specialties and accessories. Include output cabling.

- C. Shop Drawings: For each VFC indicated. Include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.
 - 1. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Each installed unit's type and details.
 - b. Factory-installed devices.
 - c. Enclosure types and details.
 - d. Nameplate legends.
 - e. Short-circuit current (withstand) rating of enclosed unit.
 - f. Features, characteristics, ratings, and factory settings of each VFC and installed devices.
 - g. Specified modifications.
 - 2. Schematic and Connection Wiring Diagrams: For power, signal, and control wiring.

1.6 INFORMATIONAL SUBMITTALS

- A. Harmonic Analysis Study and Report: Comply with IEEE 399 and NETA Acceptance Testing Specification and IEEE519 Guidelines for both Current and Voltage Distortion in a distribution system; identify the effects of nonlinear loads and their associated harmonic contributions on the voltages and currents throughout the electrical system. Analyze operating scenarios, including recommendations for VFC input filtering to limit TDD and THD(V) at each VFC to specified levels. Include measurements taken on the line side of the main distribution transformer coordinated with local electrical utility, or if not possible from the load or low voltage side of that same transformer.
- B. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around VFCs. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.
- C. Qualification Data: For qualified testing agency.
- D. Product Certificates: For each VFC, from manufacturer.
- E. Source quality-control reports.

1.7 CLOSEOUT SUBMITTALS

- A. Field quality-control reports.
- B. Operation and Maintenance Data: For VFCs to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and MCP trip settings.
 2. Manufacturer's written instructions for setting field-adjustable overload relays.
 3. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
 4. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
- C. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate, full-load currents.
- D. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.
- E. "Bill-of-Sale" Receipts: Provide original "bill-of-sale" for VFCs suitable for Owner's use to obtain rebates from Utility Company.
1. Clearly list quantity, horsepower and amount paid for each VFC.
 2. Provide "bill-of-sale" for use at meeting scheduled by Owner between Owner, Utility Company and Contractor immediately prior to Owner acceptance of Project. Utility Company Representative will initial "bill-of-sale" and make copies; Contractor maintains possession of original "bill-of-sale".

1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NFPA 70.
- D. IEEE Compliance: Fabricate and test VFC according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Packing and Shipping: Furnish all equipment in cartons and within shrink-wrapped plastic to Project in ample time for installation. Properly tag and identify equipment furnished.
- B. Storage and Protection: Store all equipment between delivery and installation in secure location that is dry, permanently enclosed, heated, and air conditioned as required to eliminate any condensation, moisture, heat or cold related damage.

1.10 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not less than 14 deg F and not exceeding 104 deg F.
 - 2. Ambient Storage Temperature: Not less than minus 4 deg F and not exceeding 140 deg F
 - 3. Humidity: Less than 95 percent (noncondensing).
 - 4. Altitude: Not exceeding 3300 feet.
- B. Interruption of Existing Electrical Systems: Do not interrupt electrical systems in facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 - 1. Notify Construction Manager and Owner no fewer than seven days in advance of proposed interruption of electrical systems.
 - 2. Indicate method of providing temporary electrical service.
 - 3. Do not proceed with interruption of electrical systems without Construction Manager's and Owner's written permission.
 - 4. Comply with NFPA 70E.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, including clearances between VFCs, and adjacent surfaces and other items.

1.11 COORDINATION

- A. Coordinate features of motors, load characteristics, installed units, and accessory devices to be compatible with the following:
 - 1. Torque, speed, horsepower, overall power, and other electrical requirements of the load.
 - 2. Ratings and characteristics of supply circuit and required control sequence.
 - 3. Distance of VFC from load and conditions of signal cable installation.
 - 4. Ambient and environmental conditions of installation location.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.
- C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.12 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.

1.13 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
 - 3. Indicating Lights: Two of each type and color installed.
 - 4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
 - 5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. ABB.
 - 2. AC Technology International Ltd (AC Tech); part of the Lenze Group.
 - 3. Square D; a brand of Schneider Electric.
 - 4. Yaskawa America, Inc; Drives Division.
- B. General Requirements for VFCs: Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C.
- C. Application: Variable torque.
- D. VFC Description: Variable-frequency power converter (rectifier, dc bus, and IGBT, PWM inverter) factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.
 - 1. Units suitable for operation of NEMA MG 1, Design A and Design B motors as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
 - 2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
 - 3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

- E. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.
- F. Output Rating: Three-phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.
- G. Unit Operating Requirements:
 - 1. Input AC Voltage Tolerance: Plus 10 and minus 15 percent of VFC input voltage rating.
 - 2. Input AC Voltage Unbalance: Not exceeding 3 percent.
 - 3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
 - 4. Minimum Efficiency: 97 percent at 60 Hz, full load.
 - 5. Minimum Displacement Primary-Side Power Factor: 96 percent under any load or speed condition.
 - 6. Minimum Short-Circuit Current (Withstand) Rating: 42 kA.
 - 7. Ambient Temperature Rating: Not less than 14 deg F and not exceeding 104 deg F.
 - 8. Ambient Storage Temperature Rating: Not less than minus 4 deg F and not exceeding 140 deg F
 - 9. Humidity Rating: Less than 95 percent (noncondensing).
 - 10. Altitude Rating: Not exceeding 3300 feet.
 - 11. Vibration Withstand: Comply with IEC 60068-2-6.
 - 12. Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
 - 13. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
 - 14. Speed Regulation: Plus, or minus 5 percent.
 - 15. Output Carrier Frequency: Selectable; 0.5 to 12 minimum kHz.
 - 16. Minimum 0.14 μ s Dt rise time or other improved technology which limits transient voltage spikes, such as soft switching.
 - 17. Stop Modes: Programmable; includes fast, free-wheel, high slip and dc injection braking.
- H. Inverter Logic: Microprocessor based, 32 bit, isolated from all power circuits.
- I. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.
- J. Internal Adjustability Capabilities:
 - 1. Minimum Speed: 5 to 25 percent of maximum rpm.
 - 2. Maximum Speed: 80 to 100 percent of maximum rpm.
 - 3. Acceleration: 0.1 to 999.9 seconds.
 - 4. Deceleration: 0.1 to 999.9 seconds.
 - 5. Current Limit: 30 to minimum of 150 percent of maximum rating.
- K. Self-Protection and Reliability Features:
 - 1. Input transient protection by means of surge suppressors to provide three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
 - 2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.

3. Under- and overvoltage trips.
 4. Inverter overcurrent trips.
 5. VFC and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved.
 6. Critical frequency rejection, with three selectable, adjustable deadbands.
 7. Instantaneous line-to-line and line-to-ground overcurrent trips.
 8. Loss-of-phase protection.
 9. Reverse-phase protection.
 10. Short-circuit protection.
 11. Motor overtemperature fault.
- L. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.
- M. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.
- N. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
- O. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
- P. Integral Input Disconnecting Means and OCPD: NEMA AB 1, instantaneous-trip circuit breaker with pad-lockable, door-mounted handle mechanism.
1. Disconnect Rating: Not less than 115 percent of VFC input current rating.
 2. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.
 3. Auxiliary Contacts: NO/NC, arranged to activate before switch blades open.
 4. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
 5. NC or NO alarm contact that operates only when circuit breaker has tripped.

2.2 CONTROLS AND INDICATION

A. All VSDs:

1. Adjustments accessible from a keypad integral to VSD.

2. Auto/Manual, Start/Stop, and speed selection accessible on the front of the controller.
 3. Power-on, run and trip monitor indications displayed by backlit LCD on the front of the controller.
 4. Linear timed acceleration and deceleration, individually adjustable with 0.1 - 600 seconds range.
 5. Minimum 40:1 controlled speed range.
 6. Minimum 0.1-120 Hz output frequency range.
 7. Adjustable Volts/Hz ratio with both factory preset and custom tunable options. Voltage boost adjustable in addition to V/Hz ratio.
 8. Controller capable of restarting with the motor coasting in either forward or reverse direction without tripping.
 9. Minimum Hertz (0-50 percent), maximum Hertz (50-100 percent).
 10. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display VFC status, alarms, and energy usage. Allows VFC to be used with an external system within a multidrop LAN configuration; settings retained within VFC's nonvolatile memory.
 - a. Network Communications Ports: Ethernet and RS-422/485.
 - b. Embedded BAS Protocols for Network Communications: ASHRAE 135 BACnet and/or Echelon LonWorks; protocols accessible via the communications ports.
- B. All “General Purpose” drives, optional for “Micro” drives:
1. Status Lights: Door-mounted LED indicators displaying the following conditions:
 - a. Power on.
 - b. Run.
 - c. Overvoltage.
 - d. Line fault.
 - e. Overcurrent.
 - f. External fault.
 2. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
 - a. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
 - b. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.

- 1) Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.
3. Historical Logging Information and Displays:
 - a. Real-time clock with current time and date.
 - b. Running log of total power versus time.
 - c. Total run time.
 - d. Fault log, maintaining last four faults with time and date stamp for each.
4. Indicating Devices: Digital display mounted flush in VFC door and connected to display VFC parameters including, but not limited to:
 - a. Output frequency (Hz).
 - b. Motor speed (rpm).
 - c. Motor status (running, stop, fault).
 - d. Motor current (amperes).
 - e. Motor torque (percent).
 - f. Fault or alarming status (code).
 - g. PID feedback signal (percent).
 - h. DC-link voltage (V dc).
 - i. Set point frequency (Hz).
 - j. Motor output voltage (V ac).
5. Control Signal Interfaces:
 - a. Electric Input Signal Interface:
 - 1) A minimum of 2 programmable analog inputs: 0- to 10-V dc and 4- to 20-mA dc.
 - 2) A minimum of six multifunction programmable digital inputs.
 - b. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BAS or other control systems:
 - 1) 0- to 10-V dc.
 - 2) 4- to 20-mA dc.
 - 3) Potentiometer using up/down digital inputs.
 - 4) Fixed frequencies using digital inputs.
 - c. Output Signal Interface: A minimum of 2 programmable analog output signal(s) (0- to 10-V dc or 4- to 20-mA dc), which can be configured for any of the following:
 - 1) Output frequency (Hz).
 - 2) Output current (load).
 - 3) DC-link voltage (V dc).
 - 4) Motor torque (percent).
 - 5) Motor speed (rpm).
 - 6) Set point frequency (Hz).

- d. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
 - 1) Motor running.
 - 2) Set point speed reached.
 - 3) Fault and warning indication (overtemperature or overcurrent).
 - 4) PID high- or low-speed limits reached.
- 6. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display VFC status and alarms and energy usage. Allows VFC to be used with an external system within a multidrop LAN configuration; settings retained within VFC's nonvolatile memory.
 - a. Network Communications Ports: Ethernet and RS-422/485.
 - b. Embedded BAS Protocols for Network Communications: ASHRAE 135 BACnet and/or Echelon LonWorks; protocols accessible via the communications ports.

2.3 LINE CONDITIONING AND FILTERING

- A. Input Line Conditioning: Provide 3 percent AC line reactor or 5% input impedance between the line and the drive. Impedance can be either through dual DC bus reactors, AC line reactor, or a combination of the two.
- B. Output Filtering: For lead lengths over 50 feet, provide 5 percent AC load reactor between the drive and the load.
- C. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3 for Category C2.

2.4 PROTECTION

- A. All VSDs:
 - 1. Lockable enclosure containing drive, line reactor, and fused exterior disconnect protecting all components. Enclosure large enough to facilitate ease of service, configured to fit in available mounting location and allow for rapid change-out of micro drive.
 - 2. Includes capability of riding through power dips up to 2 seconds without a controller trip depending on load and operating condition. During ride through, drive uses energy generated by the rotating load as a power source for all electronic circuits.
 - 3. Instantaneous electronic trip when the current demands of the inverter exceed its intermittent rating, 300 percent maximum.
 - 4. Electronic overload circuit to protect AC motors operated by the VSD output from extended overload operation on an inverse time basis UL and NEC recognized as motor protection.
 - 5. Enclosure, fuses, circuit breakers, and contactors as required allowing use as motor protection per strictest of regulatory requirements having jurisdiction.

6. Minimum 75 percent input line under voltage trip; average 120 percent over voltage.
 7. Line-to-line and line-to-ground short circuit protection.
- B. All “General Purpose” drives, optional for “Micro” drives:
1. Lockable exterior disconnects.
 2. Internal disconnect to isolate the drive for service when in bypass operation.
 3. Includes capability of riding through power dips up to 10 seconds without a controller trip depending on load and operating condition. During ride through, drive uses energy generated by the rotating load as a power source for all electronic circuits.
 4. Minimum 42,000 RMS AISC fault withstand capability.
 5. Electronic trip when the current demands of the inverter exceed its intermittent rating for 3 seconds, 150 percent maximum.
 6. Electronic overload circuit to protect AC motors operated by the VSD output from extended overload operation on an inverse time basis UL and NEC recognized as motor protection.
 7. Fuses, circuit breakers, and contactors as required allowing use as motor protection per strictest of regulatory requirements having jurisdiction.
 8. Minimum 80 percent input line under voltage trip; average 110 percent over voltage.
 9. Line-to-line and line-to-ground short circuit protection.
 10. Input 3-phase AC line reactor (DC link not acceptable).

2.5 BYPASS SYSTEMS

- A. “Micro” Drive: No bypass required. Provide “Spare” drives as follows:
1. For each building in project where “Micro” drives are utilized, provide one spare drive of each unique configuration (voltage/phase/HP) “Micro” Drive installed as part of project, minimum two if only one configuration is used. Deliver spare drives to Owner and provide Architect with letter signed by owner confirming receipt of spare “Micro” drives.
- B. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.
- C. Bypass Mode: Field-selectable automatic or manual, allows local and remote transfer between power converter and bypass contactor and retransfer, either via manual operator interface or automatic control system feedback.

- D. Bypass Controller: Three contactor bypass or two-contactor-style bypass that allows motor operation via the power converter or the bypass controller; with input isolating switch and barrier arranged to isolate the power converter and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode.
1. Bypass Contactor: Load-break, IEC-rated contactor.
 2. Output Isolating Contactor: Non-load-break, IEC-rated contactor.
 3. Input Isolating Contactor: Non-load-break, IEC-rated contactor.
 4. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.
- E. Bypass Contactor Configuration:
1. NORMAL/BYPASS selector switch.
 2. HAND/OFF/AUTO selector switch.
 3. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFC while the motor is running in the bypass mode.
 4. Control Circuits: 120-V ac
 5. Overload Relays: NEMA ICS 2.
 - a. Solid-State Overload Relays:
 - 1) Switch or dial selectable for motor-running overload protection.
 - 2) Sensors in each phase.
 - 3) Class 10/20 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
 - 4) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
 - 5) Analog communication module.
 - b. NO isolated overload alarm contact.
 - c. External overload reset push button.

2.6 OPTIONAL FEATURES

- A. Multiple-Motor Capability: VFC suitable for variable-speed service to multiple motors. Overload protection shuts down VFC and motors served by it, and generates fault indications, when overload protection activates.
1. Configure to allow two or more motors to operate simultaneously at the same speed; separate overload relay for each controlled motor.

2. Configure to allow two motors to operate separately; operator selectable via local or remote switch or contact closures; single overload relay for both motors; separate output magnetic contactors for each motor.
 3. Configure to allow two motors to operate simultaneously and in a lead/lag mode, with one motor operated at variable speed via the power converter and the other at constant speed via the bypass controller: separate overload relay for each controlled motor.
- B. Damper control circuit with end of travel feedback capability.
 - C. Sleep Function: Senses a minimal deviation of a feedback signal and stops the motor. On an increase in speed-command signal deviation, VFC resumes normal operation.
 - D. Motor Preheat Function: Preheats motor when idle to prevent moisture accumulation in the motor.
 - E. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.
 - F. Remote digital operator kit.
 - G. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer and a notebook computer.

2.7 ENCLOSURES

- A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.
 1. Indoor Locations: Type 12 or Type 1.
 2. Exterior Locations: Type 3r

2.8 ACCESSORIES

- A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VSD enclosure cover unless otherwise indicated. Pilot Lights: LED types; colors as required; push to test.
- B. Reversible NC/NO bypass contactor auxiliary contact(s).
- C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.
- D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.
 1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.

E. Supplemental Digital Meters:

1. Elapsed-time meter.
2. Kilowatt meter.
3. Kilowatt-hour meter.

F. Cooling Fan and Exhaust System: As required for NEMA 250, Type 12; UL 508 component recognized: Supply fan, with composite or stainless-steel intake and exhaust grills and filters; 120 -V ac; obtained from integral CPT.

G. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.

H. Output Cable: Provide sufficient special purpose VFC output cable for all power wiring between all VFCs and their respective loads, sized per the stricter of NEC, drive and motor manufacturer's recommendations, or as shown on drawings.

1. Comply with NEMA WC 70/ICEA S-95-658 for metal-clad cable, Type MC with ground wire.
2. VFC Cable: Type TC-ER low-capacitance shielded VFC cabling with oversized crosslinked polyethylene insulation over tin-coated high strand count conductors, spiral-wrapped foil plus full coverage braided shields in direct contact with symmetrical ground conductors (one per power conductor), and sunlight- and oil-resistant outer PVC jacket.
3. Capacitance value core to core less than 75pF/m, core to shield less than 150pF/m.
4. Basis of design: Americable TC-ER VFD cable, or equal by Beldon or Carol.

2.9 SOURCE QUALITY CONTROL

A. Testing: Test and inspect VFCs according to requirements in NEMA ICS 61800-2.

1. Test each VFC while connected to a motor that is comparable to that for which the VFC is rated.
2. Verification of Performance: Rate VFCs according to operation of functions and features specified.

B. VFCs will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance.

- B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.
- E. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 INSTALLATION

- A. Coordinate layout and installation of VFCs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required access, workspace clearances, and required clearances for equipment access doors and panels. Install VFCs in an upright position.
- B. Install VFCs including all transformers, line reactors, bypass enclosures and other accessories, on walls or equipment racks level, upright, with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall or floor. For controllers not on walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Comply with NECA 1.

3.3 CONTROL AND POWER WIRING INSTALLATION

- A. Install wiring between VFCs and remote devices and facility's central-control system. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- B. Bundle, train, and support line, load, and control wiring in separate enclosures.
- C. Install output cabling in strict accordance with manufacturers' recommendations. Provide for strain relief and cabling protection from damage. Verify cable length prior to installation and provide output line reactor if length exceeds that specified.
- D. Connect selector switches and other automatic control devices where applicable.
 - 1. Connect selector switches to bypass only those manual- and automatic control devices that have no safety functions when switches are in manual-control position.
 - 2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.4 IDENTIFICATION

- A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Division 23 Section "Identification for HVAC Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each VFC with engraved nameplate.
 - 3. Label each enclosure-mounted control and pilot device.
- B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- E. Tests and Inspections:
 - 1. Inspect VFC, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
 - 2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
 - 3. Test continuity of each circuit.
 - 4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Construction Manager before starting the motor(s).
 - 5. Test each motor for proper phase rotation.
 - 6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 8. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but before Final Completion and Acceptance, perform an infrared scan of each VFC. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - c. Re-tighten all connections as required.
 - d. Generate report for inclusion in close-out documentation including color thermography printouts showing acceptable results.
 - e. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each VFC 11 months after date of Substantial Completion.
 9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- F. VFCs will be considered defective if they do not pass tests and inspections.
- G. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.6 STARTUP SERVICE

- A. Provide services of a manufacturer's factory –authorized service representative to inspect complete installation, start and adjust each drive, and train the Owner in drive operation, maintenance, and adjustment.
- B. Coordinate services of adjustable speed drive factory –authorized service representative, TAB Agency, and Controls Technicians to insure proper coordinated operation and system control.
- C. Complete additional installation and startup checks according to manufacturer's written instructions.
- D. Submit letter from manufacturer's factory –authorized service representative attesting to the satisfactory completion of installation and startup, with attached start-up / calibration forms for each drive with all appropriate adjustment settings itemized.

3.7 ADJUSTING

- A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.
- B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
- C. Fully adjust each adjustable speed drive including maximum and minimum speeds, rates of speed change, calibration, testing, and as otherwise required to meet the operational intent and all control sequences.
- D. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Architect and Construction Manager before increasing settings.
- E. Set the taps on reduced-voltage autotransformer controllers.
- F. Set field-adjustable circuit-breaker trip ranges as specified in Division 26.

3.8 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.
- B. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.
 - 1. Submit letter from factory-authorized service representative attesting to the satisfactory completion of Owner's training, signed by Owner's representatives.

END OF SECTION 23 29 00

SECTION 23 31 00 - DUCTWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Sheet metal duct materials and construction.
 - 2. Sheet metal duct fittings materials and construction.
 - 3. Flexible duct and connectors.
 - 4. Ductwork ancillary components materials and construction.

1.3 DEFINITIONS

- A. Aspect Ratio: The ratio of duct width to height.
- B. Hydraulic Radius: The ratio of duct cross section area to perimeter, or practically, a term used to define flow resistance of duct with differing aspect ratios, with resistance to flow being approximately proportional to hydraulic radius.
- C. NRC: Noise Reduction Criteria
- D. Offset: A change in the duct centerline location but not direction occurring within one piece of duct.
- E. RGD: Registers, Grilles, and/or Diffusers
- F. STC: Sound Transmission Class

1.4 PERFORMANCE REQUIREMENTS

- A. Provide duct system able to withstand the loads and stresses described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and these contract documents.
- B. Fabricate outdoor duct and casings to withstand wind load and snow load indicated on Structural series drawings and specifications. Calculate the snow load as a negative pressure on the top duct surface.
- C. Fabricate ductwork able to withstand the forces imposed by the support and restraint system. Refer to Specification Section 23 05 48 – Mechanical Wind Load Control for additional information and requirements.

- D. Fabricate ductwork used for contaminant (dust, fume, smoke, chips, etc...) removal or control in accordance with applicable NFPA requirements, the industrial ventilation requirements of both SMACNA and the American Conference of Governmental Industrial Hygienists Industrial Ventilation Manual, and any additional requirements of these contract documents.
- E. Provide all duct systems continuously electrically bonded to ground.

1.5 SUBMITTALS

- A. Comply with requirements of SECTION 01 33 00 - Submittals and as modified below.
- B. Identify in writing, any proposed deviations from contract Drawings and Specifications.
 - 1. Highlight all changes from plans required by obstructions and job conditions.
 - 2. Bring any proposed deviations from contract plans and specifications to Architect's attention in writing, by separate letter attached to submittal with proposed deviations, along with samples for clarification, demonstrating benefit to Owner.
- C. Product Data: Submit for approval annotated Shop Construction Standards showing upgrades as required for conformance in detail to specifications for all factory and shop fabricated air ducts, components, and accessories.
- D. Shop Drawings:
 - 1. Prepare and submit 1/4" = 1' scale or larger shop drawings for all areas within 30 days after contract award unless Architect, Construction Manager, and Owner agree in writing upon another shop drawing schedule. Refer to section 01 33 00 – Submittals for additional information. Include approved Ductwork Accessories after approval as part of Section 23 33 00 submittals.
 - a. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
 - b. Factory- and shop-fabricated ducts and fittings.
 - c. Duct layout indicating sizes, configuration, liner material, and SMACNA pressure class required for all duct.
 - d. Indicate duct elevation above floor (top and bottom of ducts), bottom of structure especially at critical passages, and ceiling height for each room.
 - e. Dimensions of main duct runs from building grid lines.
 - f. Fittings.
 - g. Reinforcement and spacing.
 - h. Seam and joint construction.
 - i. Penetrations through fire-rated and other partitions.
 - j. Equipment and accessories installation based on equipment being used on Project.
 - k. Indicate locations and sizes of all dampers, turning vanes, access doors and panels, and other required accessories.
 - l. Hangers and supports, including methods for duct and building attachment, wind restraints, and vibration isolation.

E. Coordination Drawings:

1. Prepare 1/4" = 1' scale or larger drawings for all areas requiring coordination drawings within 15 days after Duct Shop Drawing approval unless Architect, Construction Manager, and Owner agree in writing upon another coordination drawing schedule. Refer to Section 01 31 00 – Project Management and Coordination, Section 01 33 00 – Submittals and Section 23 33 00 – Ductwork Accessories, for additional information.
 - a. Begin with approved shop drawings.
 - b. Incorporate dimensions shown on contract documents and those of actual equipment proposed. (Including duct, piping, equipment, suspended ceiling components, light fixtures, structural steel adjacent to duct, service clearance, etc.)
 - c. Detail duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
 - d. Show adequate sections, elevations and plan views required to demonstrate reasonable installation and service is possible.
 - e. Include reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.
 - f. Include all structural members to which duct will be attached.
 - g. Coordinate with and include TAB agency commentary as described in Section 23 05 93.
 - h. Include size and location of all floor, wall, and roof openings. Highlight penetrations of smoke barriers and fire-rated construction
 - i. Include items penetrating finished ceiling including the following:
 - 1) Lighting fixtures.
 - 2) Air outlets and inlets.
 - 3) Mechanical Equipment.
 - 4) Fire Alarm Devices.
 - 5) Speakers.
 - 6) Sprinklers.
 - 7) Soffits.
 - 8) Access panels.
 - 9) Perimeter moldings.
2. Submit Coordination Drawings to Architect, Construction Manager, and each affected Prime Contractor for review and coordination in accordance with the schedule agreed upon during the coordination meetings.

3. Deliver originals and additional copies of revised signed and accepted Complete Coordination Drawings as follows:

- a. Owner: originals
- b. Architect: 1 copy
- c. Construction Manager: 1 copy.
- d. Each affected other Prime Contractor: 1 copy.

- F. Welding certificates for duct welders. Refer to Section 23 05 00 – Common Work Results for HVAC for detailed requirements.

1.6 CLOSEOUT SUBMITTALS

- A. Contract Closeout Submittals: Comply with requirements of SECTION 01 77 00 – Closeout Procedures, including submission of operating and maintenance instructions as item in "Operating and Maintenance Data" manual described in that section.
- B. Field quality-control reports – duct leakage, duct cleanliness.

1.7 QUALITY ASSURANCE

- A. Provide ductwork by experienced and approved workers specializing in sheet metal fabrication and installation in accordance with the stricter of the below referenced standards and the requirements outlined in these contract documents.
- B. Referenced Standards
 1. The latest editions of the publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
 2. American Conference of Governmental Industrial Hygienists
 - a. “Industrial Ventilation – A Manual of Recommended Practice for Design”, for contaminant control and industrial ventilation design
 3. American Society of Civil Engineers (ASCE):
 - a. ASCE7 Minimum Design Loads for Buildings and Other Structures
 4. American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE)
 - a. ASHRAE / ANSI 62.1 – Ventilation for Acceptable Indoor Air Quality.
 - b. ASHRAE / ANSI 90.1 – Energy Standard for Buildings Except Low-Rise Residential Buildings
 5. American Welding Society (AWS)
 - a. AWS D1.1, "Structural Welding Code - Steel," for hangers and supports.
 - b. AWS D1.2, "Structural Welding Code - Aluminum," for aluminum supports.
 - c. AWS D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

6. American Society for Testing and Materials (ASTM):
 - a. A167 99 Standard Specification for Stainless and Heat Resisting Chromium Nickel Steel Plate, Sheet, and Strip
 - b. A653-09 Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy coated (Galvannealed) by the Hot-Dip process
 - c. A1011-09a Standard Specification for Steel, Sheet and Strip, Hot rolled, Carbon, structural, High-Strength Low-Alloy, High Strength Low-Alloy with Improved Formability, and Ultra-High Strength
 - d. B209 07 Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate
 - e. C1071-05e1 Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)
 - f. D6386 Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting
 - g. D7803 Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Powder Coating
 - h. E84-09a Standard Test Method for Surface Burning Characteristics of Building Materials
7. National Air Duct Cleaners Association (NADCA):
 - a. ACR “Assessment, Cleaning and Restoration of HVAC Systems”, for duct cleanliness standards.
8. National Fire Protection Association (NFPA):
 - a. 90A Standard for the Installation of Air Conditioning and Ventilating Systems
 - b. 96 Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations
9. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
 - a. HVAC Duct Construction Standards, Metal and Flexible
 - b. HVAC Air Duct Leakage Test Manual
10. Underwriters Laboratories, Inc. (UL):
 - a. 181 Factory Made Air Ducts and Air Connectors
 - b. 555 Standard for Fire Dampers
 - c. 555S Standard for Smoke Dampers

PART 2 - PRODUCTS

2.1 DUCT MATERIALS

A. General Material Requirements:

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated.
2. Provide sheet metals per mill specs and free of pits, voids, seam or roller marks, stains, discolorations, inadvertent bends and kinks, and other imperfections.

B. Standard Supply, Return and Exhaust: Galvanized steel, ASTM A-653/653M G90, lock forming quality, unless otherwise specified.

C. Standard Supply, Return and Exhaust duct which will be exposed to view in the finished project and will not be externally insulated or painted: Galvannealed steel, ASTM A-653/653M G90, lock forming quality, unless otherwise noted.

D. Standard Supply, Return and Exhaust duct which will be exposed to view in the finished project and will be painted: Galvannealed steel, ASTM A-653/653M G90, lock forming quality, prepared for painting via mill phosphatizing and subsequent heat treatment in accordance with ASTM D6386 and ASTM D7803 as applicable, unless otherwise noted.

E. Ducts serving Locker Rooms and Locker Room Toilets, Natatoriums, Shower Rooms, Crawlspace, Dryer Vents, and Other High Humidity Areas: ASTM B-209 Aluminum alloy 3003 with H14 temper, with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

F. Kitchen supply and exhaust duct: ASTM A 480/A 480M, Type 304L or 316L Stainless-Steel Sheets; cold rolled, annealed. Minimum surface finish for concealed duct No. 2B exterior of duct, No. 2D interior of duct. Minimum surface finish for duct exposed to view in occupied spaces, No. 4 polish.

G. Industrial Arts or Technical Shop duct and hood fabrication where called for: ASTM A 1008/A 1008M Carbon-Steel Sheets, with matte finish for exposed ducts, prepared for painting in accordance with section 23 05 00 – “General Requirements for HVAC” and Division 9 sections on painting.

H. Flexible Ducts:

1. Flexible Duct (standard ventilation air register, grille, and diffuser connections where noted on Drawings. Maximum installed length to be 5'-0"): Medium pressure CPE or polymeric coated woven fiberglass cloth liner, enclosed spring steel wire, R-6 fiberglass insulation covered by metalized polyester film bi-directionally reinforced vapor barrier. Similar to types S-TL (uninsulated for field insulation), M-KE, or M-KC, with FlexFlow elbow supports, all by Thermaflex (design make).

2. Flexible Duct (Ambient Temperature abuse resistant applications similar to wood dust exhaust systems): Minimum factory temperature rating of 200 deg. F., constructed with two ply, triple overlap, fully EPDM impregnated woven abrasion resistant, fire retardant fabric with an enclosed spring steel wire, and extra abrasion resistant strip covering wire. Factory attached fittings. Type "NE" by Car-Mon Products (design make).
 3. Flexible Duct (Medium Temperature and/or abuse resistant applications similar to kiln, wood dust, and automotive exhaust systems): Minimum factory temperature rating of 700 deg. F., constructed with two ply, triple overlap, polymeric impregnated woven glass fiber cloth with an enclosed spring steel wire, and extra abrasion resistant strip covering wire. Factory attached fittings. Type "HTX" by Car-Mon Products (design make).
 4. Flexible Duct (Soldering and welding fume exhaust systems): Flame retardant, coated polyester woven cloth with spatter resistant characteristics. Single ply, double overlap, totally enclosed nonconductive helix wire, factory attached fittings. Type "PT Weldproof" by Car-Mon Products (design make).
- I. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials, and use stainless steel fasteners.

2.2 RECTANGULAR DUCTS AND FITTINGS

- A. Conform to appropriate SMACNA rectangular duct reinforcement tables and figures for the velocity-pressure classification duct construction required as defined in part three of this document, and additionally as follows.
1. Seal all joints and seams in accordance with SMACNA seal classification required for duct in question.
 - a. Additionally, seal field assembled longitudinal seams for seal class B duct.
 2. Transverse Joints: in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure for "Rectangular Duct/Transverse Joints".
 - a. For all duct requiring reinforcement, provide SMACNA T-24 or T-25 type flanged duct connection system at traverse joints.
 - 1) Joints may be factory manufactured slip on type or integrally shop fabricated onto the duct sheet metal on machinery designed for that purpose. Corner closure pieces are required at each corner.
 - 2) Manufacturers: Subject to compliance with requirements, available manufacturers offering pre-manufactured slip on reinforcement products that may be incorporated into the Work include, but are not limited to, the following:

- a) Ductmate Industries, Inc, or equal.
 - b) Lockformer TDC or equal.
 - c) Nexus PDQ type G or J or equal.
- 3. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- 4. Tie rods are not permitted on duct or plenums narrower than 72". Where an option for tie rod or heavier gauge sheet metal / shorter joint length / higher category reinforcement is presented in table, the heavier, shorter, more reinforced duct with no tie rods is required.

B. Offsets:

- 1. Where offset dimension is equal to or less than 0.2 times duct dimension in plane of offset, offset may be angled at maximum 15 degrees (SMACNA type 1).
- 2. Where offset dimension is greater than 0.2 times duct dimension in plane of offset (example: 10 x 20 duct offset in plane of 10" dimension greater than 2 inches), offset to consist of paired curved elbows, each of the required angle, combined into one fitting (SMACNA type 3).
 - a. Conform to elbow requirements as indicated below.
 - b. Offset may be replaced with paired curved elbows if required for installation, otherwise provide combined fitting.

C. Transitions of shape or cross section:

- 1. Reductions in cross section shall have a maximum included cone angle of 60 deg., with a maximum single side angle of 45 deg. from axial, unless otherwise specified in writing.
- 2. Transformations of section without a net reduction of cross section shall have no section of reduced hydraulic radius nor any local expansion of more than 15 deg. net included cone angle, as defined by ASHRAE and SMACNA.
- 3. Expansion sections, unless specifically drawn and noted otherwise, shall have:
 - a. No section of reduced hydraulic radius
 - b. No section of local expansion of more than 15 deg. net included cone angle.
 - c. No single side expansion angle of more than 15 deg. from axial unless otherwise specified in writing.

D. Elbows:

- 1. Make all changes in direction (as opposed to offsets above where direction remains the same) regardless of angle with elbow fittings unless specifically drawn and noted otherwise.

2. Curved Rectangular Elbows:

- a. Along critical pressure drop paths, provide curved rectangular elbows.
 - 1) Critical pressure drop paths shall be as indicated on drawings or if not indicated shall be considered to be entire duct run from air handling unit along mains to or from furthest terminal. Systems with more than one main branch shall be considered to have more than one critical pressure drop path.
 - 2) Provide critical path elbows with throat radius not less than dimension of duct in plane of radius or use smaller inner radius elbows with splitter vanes such that the ratio of inner to outer radius of curvature of any section of the elbow shall not be less than 1/2.
- b. Along non-critical pressure drop paths, curved rectangular elbow radius requirements may be relaxed to a throat radius not less than one half the dimension of the duct in plane of radius or use smaller inner radius with splitter vanes such that the ratio of inner to outer radius of curvature of any section of the elbow shall not be less than 1/3.
- c. Construct all curved elbows of increasing or decreasing cross section in accordance with critical pressure drop path criteria.
- d. Fabricate splitter vanes per SMACNA Duct Manual construction standards.

3. Mitered rectangular elbows

- a. Only elbows not along critical pressure drop path may be of curved or mitered construction.
- b. Mitered rectangular elbows with angle of bend under 15 deg. may have miter at duct end similar to SMACNA type 1 offset.
- c. Provide turning vanes in mitered rectangular elbows with angle of bend over 15 degrees.
- d. Mitered elbows with angle of bend over 100 deg. or less than 80 deg. shall not use commercially available 90 deg. turning vanes

4. Double Wall Turning Vanes

- a. Provide for mitered rectangular elbows of equal inlet and outlet or increasing cross section
- b. Blades of hollow double wall construction, with smaller radius sheet metal form nested outside larger radius form, tapering down gradually to and welded at double thickness edge, designed for specific spacing and alignment to minimize separation of flow and pressure drop through air duct elbows.
- c. Properly spaced to result in constant cross-section area between blades: smaller radius blades to have closer spacing
- d. Maximum spacing 3 inch, unless otherwise approved.
- e. Acoustical type where called for or where installed in acoustically lined ductwork.

f. Provide products by one of the following:

- 1) Titus or equal
- 2) Elgen or equal
- 3) Hardcast or equal.

E. Duct Branches:

1. Install branches, inlets, and outlets so that air turbulence is reduced to a minimum and air volume properly apportioned. Install airflow adjustment devices at all junctions to permit adjustment of the amount of air entering or leaving the branch.
2. Where a duct branch is to handle more than 25 percent of the air handled by the duct main, use a complete elbow as specified, assembled into a single fitting with the main duct. Size the separate branch and remaining main as shown on the drawings, and partition the division of the combined duct such that each of the branch and main have the same velocity, with cross sectional area proportional to the respective airflow. Join the leading / trailing edge where the branch and main meet airtight via welding or brazing.
3. Where a duct branch is to handle less than 25 percent of the air handled by the duct main, construct the branch connection with a 45 degree side take-off with volume damper in branch line close to takeoff. Round branches off of rectangular main, use 45 deg. entry takeoff with integral transition to round.
 - a. Supply: increase duct dimension on upstream side of branch by 25 percent, minimum 4 inch.
 - b. Return: increase duct dimension on downstream side of branch by 25 percent, minimum 4 inch.
 - c. Multiple flow direction takeoffs: provide twin entries or bell mouths.
4. Where an air-diffusion device is shown as being installed in close proximity to (less than one main duct width) the side, top, or bottom of a duct, provide a commercially manufactured vaned volume extractor fitting to allow adjustment of the air quantity and to provide an even flow of air across the device it services.

F. Duct Entries

1. Wherever air does not enter the duct system from grilles, registers, or louvers, but instead enters directly from an enclosed or exposed plenum space, provide a duct entry transition with a minimum area ratio of inlet to nominal duct size of 2:1 unless otherwise specifically shown and noted.
2. Duct entry may be angled (pyramidal or conical) or with bell-mouth radius.
 - a. Provide angled duct entries with a maximum single side angle to axial of 30 deg. Any combination of sides, top, and bottom may be angled (or conical for round duct) to suit space restrictions, but maintain the specified area ratio.
 - b. Provide bell-mouthed entries with radius as required maintaining the specified area ratio.

3. Provide entry grille or if not shown, provide at minimum 1/2 inch welded wire mesh (WWM) secured over the large side of the opening of all duct entries.

2.3 ROUND DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. Spiral lock-seam duct, joints, and fittings:

- 1) Lindab Inc.
- 2) McGill AirFlow LLC.
- 3) SEMCO Incorporated.
- 4) Sheet Metal Connectors, Inc.
- 5) Spiral Manufacturing Co., Inc.

- b. Longitudinal fusion-welded duct, joints, and fittings as described in appropriate SMACNA manuals and herein – shop fabricated.

- c. 26 ga. G-60 longitudinal snap-lock construction duct, joints, and fittings.

- B. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible", and as follows:

1. Spiral lock seam duct:

- a. Machine locked spiral seams with or without formed standing reinforcement ribs.
- b. Leakage through the duct wall and joints certified no greater than design make.
- c. Provide minimum 12 ft. long un-joined lengths, except where interrupted by fittings.

2. Longitudinal seam duct shall have fusion-welded butt seams.

- a. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
- b. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

3. Snap-lock seam duct:

- a. Limit snap-lock construction components and systems to concealed round duct run-outs to individual diffusers, registers, and grilles, in sizes 12 inch and under, with all transverse and longitudinal seams sealed.

- b. Longitudinal seams field assembled by interlocking machine formed sprung tabs, with sealant brushed on before and after assembly.
 - c. Provide minimum 10 ft. long un-joined lengths, except where interrupted by fittings or shorter lengths are required to work through existing structure.
- C. Transverse Joints - Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible", and as follows:
 - 1. 24 in. diameter and less: slip fit collars or sleeve couplings, reinforced by rolled beads, insertion length 2 inch. Secure with hexagon head drill point screws or other approved mechanical fasteners 6 inch o.c. max and duct sealant.
 - 2. Over 24 inch to 42 inch diameter, general, concealed joints: Provide roll formed, welded angle ring flanges similar to SMACNA T-24 or T-25 configuration. Attach flange to duct with internal stitch or button welds 6 inch o.c. max and duct sealant. Size angle ring gauges per SMACNA recommendations. Secure with #10 "Tec" screws 6 inch o.c. maximum, seal with closed cell gasket.
 - 3. Exposed over 24 inch diameter, all over 42 inch diameter: two piece angle ring flanges, loose fit outer ring in a "Van Stone" configuration. Provide a 5/8 inch flange inner ring as a gasketing surface for sealing, integrally rolled or attached to the pipe with internal button or stitch welds 6 inch o.c. max and duct sealant. Provide outer rolled, welded angle ring sized per SMACNA recommendations. Secure with bolts 8 inch o.c. maximum, seal with closed cell gasket.
- D. Elbows:
 - 1. Fabricated to a centerline radius of minimum 1.5 times the cross-section diameter.
 - a. Where space constrictions do not allow specified centerline radius or where shown as such on drawings only, provide mitered elbow of fully welded construction with single thickness turning vanes spaced 3 inch o.c. max.
 - 2. For use with snap-lock round duct, where allowed as described above: Gored adjustable elbows, seal adjustable joints after installation.
 - 3. For standard bends (ex. 45 deg. and 90 deg.), diameters through 9 inch: Two-section stamped and welded 22 ga. elbows.
 - 4. Diameters 10 inch through 30 inch, any angle: Gored standing seam construction similar to United McGill "UNI-SEAM". Less than 36 deg. - two gores, 36 deg. to 72 deg. - three gores, over 72 deg. - five gores.
 - 5. Diameters over 30 inch and odd angles under 10 inch: Gored construction with gores stitch welded 6 inch o.c. max and sealed with duct sealant. Less than 35 deg. - two gores, 36 deg. to 71 deg. -three gores, over 71 deg. - five gores.

- E. Tees and Lateral Branches: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible", and as follows:

1. Bull-Headed Tees:

- a. Provide wye fitting with subsequent partial bend elbows for critical run bull-headed tees.
- b. Provide capped main and twin lateral branches as described below for general purpose bull-headed tees.
- c. Provide "bird-mouthed" fitting with turning vanes only where space restrictions require and where specifically shown as such on the drawings.

2. Fabricate lateral tees and all branches with fittings as described herein:

- a. Fabricate to longitudinal welded duct standards. Where possible, provide gored standing seam construction similar to United McGill "UNI-SEAM", otherwise stitch or button welded or riveted. Seal all joints.
- b. Fitting entrance free of weld build-up or spatter, burrs, or irregularities, not projecting into either the main or branch runs.
- c. Provide manual volume damper at all branch connections.
- d. Typical round branch connections to round main duct, provide 45 deg. reducing lateral takeoff fitting, with subsequent elbow resulting in required branch angle to main.
 - 1) Where space restrictions do not permit this combination, provide 90 deg. angled rectangular to round takeoff fitting "birdmouthed" to main, or conical takeoff with similar loss coefficient.
 - 2) For critical run (ie. maximum pressure drop) round branch connections to round main ductwork, provide high performance 45 deg. reducing conical lateral takeoff fitting, with subsequent elbow resulting in required branch angle to main.
 - 3) Exposed, duct side mounted register connections may be tapped into side wall of length of duct. Where an air-diffusion device is shown as being installed in close proximity to (less than one main duct width) the side, top, or bottom of a duct, provide a commercially manufactured vaned volume extractor fitting to allow adjustment of the air quantity and to provide an even flow of air across the device it services.

F. Turning Vanes:

1. As described for mitered rectangular elbows of unequal inlet and outlet cross section above.

G. Offsets:

1. All offsets to consist of paired curved elbows, each of the required angle, combined into one fitting.

H. Transitions of shape or cross section and duct entries:

1. As described for rectangular duct above.

2.4 EXTERIOR DUCT

- A. Construction as detailed above with the additional requirements listed herein.
- B. Seal all exterior duct completely water tight, including all longitudinal and transverse seams, fittings, and branch connections. Seal both during assembly and from the exterior. Use only exterior all weather grade gaskets and sealants. Apply sealants neatly, avoiding exposed sealant on surface. Where sealant must be exposed for function apply in neat fillets.
- C. Fabricate all transverse joints using an **INTEGRAL** standing flange reinforcement similar to SMACNA T-24 or T25 as described in the SMACNA HVAC Duct Construction Standards Manual. Use of “slip-on” reinforcing flanges not permitted.
- D. Install all exterior duct with minimum 1 inch per 10 ft pitch to avoid standing water puddles on top surface.

2.5 EXPOSED DUCT SPECIAL CONSIDERATIONS

- A. Provide aluminum (as required above) or paintable galvanized steel for all exposed supply, return and exhaust duct which will not be externally insulated. Mill phosphatizing in accordance with ASTM A2092 is acceptable material. Use forming lubricants which are compatible with specified painting systems and provide painters with factory recommendations for appropriate and compatible solvents, primers, etc...
- B. Welds: exposed welds ground smooth and all weld spatter scraped or ground off.
- C. Sealants: use only paintable sealants, applied neatly, avoiding exposed sealant on surface. Where sealant must be exposed for function apply in neat fillets.
- D. Avoid all shipping and handling damage to surfaces. Replace pieces that are damaged and not repaired so that repair is not visible.
- E. Joints: rotate all spiral seams of round duct so as to form continuous helical spiral. Carefully coordinate installation of exposed duct side mounted register connections as required.
- F. Provide tapered “ramp” couplings for joints where allowed by size.

2.6 TYPE I AND TYPE II KITCHEN HOOD EXHAUST DUCTS:

- A. Type I and Type II hood service duct: in compliance with NFPA 96, all related code requirements, and the additional requirements of this section.
- B. Material: 18 gage minimum stainless steel, number 4 polish for duct exposed to view in finished space.
- C. Construction:
 - 1. Fabricate duct from minimum 18 gauge externally continuously tig welded stainless steel, not cross-broken.
 - 2. Grind and polish all welds to match #4 finish and remove all weld heat discoloration. Distortion from overheating or forcing is unacceptable.
 - 3. Smooth radius elbows with ratio of outer radius to inner radius no greater than 2, smooth transitions with no steps, no mechanical fasteners extending into airstream, eliminate all eddies and other locations where grease or condensate will inadvertently accumulate.
 - 4. Prove liquid tight at all welds, seams, and joints.
- D. Slope duct continuously per code and NFPA, minimum one quarter inch per foot (1:48 or 2% slope) up to 75 feet horizontal, or above 75 feet horizontal at one inch per foot (1:12 or 8.3% slope) preferably back to the equipment, or to a grease reservoir.
 - 1. Where ducts are not self-draining to equipment provide low point grease reservoir / drain pockets at all duct low points:
 - a. Full width of duct, welded construction, twelve inches (12") long in direction of airflow and one inch (1") deep minimum, bottom sloped deeper towards drain for positive drainage with welded on stainless steel drain pipe nipple with 3/4" NPT threaded connection point outside of insulation.
 - b. Type I service connection: valve and capped hose thread for periodic grease collection
 - c. Type II service connection: trapped as required for system pressure and connected to condensate drain pipe as specified, extended to sanitary sewer through grease trap.
- E. Verify size of hood and fan duct connections in field, provide duct to fit equipment connections with smooth transitions to duct size indicated or if not indicated on drawings to next full inch size smaller than that which would have velocity of 1500 fpm at given cfm. Configure duct so that duct velocity is not less than 500 fpm at any point in the duct.
- F. Provide access doors or panels for duct cleaning on horizontal duct at grease reservoir / drain pockets, at 12 foot intervals, and at each change of direction. Access doors or panels shall be of the same material and thickness of the duct with reinforced flanges, flush interior surfaces, water and grease-tight high temperature gaskets and sealants, and easily reusable fire rated insulation covers.

1. Type I access door assemblies complete, rated for 1500 degrees F service.
- G. Where clearance to other construction permits, double-wall insulated factory-built grease duct and accessories, inner and outer walls 300 series stainless steel, UL labeled and complying with NFPA 96 may be used in lieu of specified materials, with installation in compliance with the manufacturers' requirements. Convert any square and rectangular duct shown on the drawings to round size of equal or greater hydraulic radius with custom transitions meeting all the requirements of this specification.

2.7 DUST COLLECTOR DUCTWORK

A. General:

1. In accordance with approved submittal drawings and manufacturer's recommendations.
2. Include all necessary accessory fittings and custom adapters required for equipment connections.
3. Round high velocity abrasive construction, rated for negative 12 inch w.g., per SMACNA Standards.
4. Exterior ductwork to be of "galvaneal" mill phosphatized galvanized steel, sealed watertight, painted with (2) coats of "Galvagrip", coated with exterior rated acoustical damping compound, and painted again with two coats of UV resistant exterior paint in color to match equipment.
5. Provide flexible duct from blast-gate damper to each piece of equipment unless otherwise required or specifically noted.

B. Branch Duct Balancing and Shut Off Dampers:

1. Blast gate of cast aluminum construction with enclosed sliding gate and adjustment locking set screw. Provide second screw through blast gate blade to fix maximum open position at setting made during system testing and balancing, such that each blast gate may adjust from fully closed to the balanced set point.
2. Install 6 ft – 6 inches above finished floor unless otherwise specifically noted or directed.
3. Provide for each separate piece of equipment served.

C. Equipment connections:

1. Standard Types:
 - a. Provide dust collection connections by manufacturer of equipment served where same meets requirements of Industrial Ventilation Manual, and is properly sized and designed for specific equipment application.

2. Special Application:

- a. Where hoods furnished by collector or equipment manufacturer do not meet requirements of Industrial Ventilation Manual, fabricate special hoods for each individual piece of equipment to be connected to the dust collection system. Fabricate hoods in accordance with requirements of Industrial Ventilation Manual, as depicted in details, or as required for proper dust pick up. Field verify all pertinent dimensions of existing equipment prior to creation of submittal shop drawings; incorporate field conditions accurately in proposed fabrication submittal.

2.8 DUCTWORK ANCILLARY COMPONENTS

- A. In general, duct accessories associated with specialized requirements which are called out and / or scheduled on the drawings are specified in section 23 33 00 – Air Duct Accessories. The ancillary components included in this section are generally required in all air duct systems, need not be specifically called for on the drawings other than by specification or standard symbols and abbreviations, and are required to be detailed in the shop standards submittal.
- B. Acoustical and Thermal Duct Liner:
 1. Refer to specification section 23 07 00 – HVAC Insulation for duct liner specifications.
 2. Where duct liner is used, enlarge ductwork in both directions by double the nominal duct liner thickness to size required to provide for free area dimensions as shown on the drawings.
 3. Duct liner used for sound attenuation purposes only to be minimum 1 inch thick or thicker as specified on the drawings.
 4. Duct liner used in lieu of external thermal insulation is required to meet the insulation value and associated thickness requirements of section 23 07 00.
 5. Duct liner materials and installation, as specified in section 23 07 00, may be submitted under either this section or in section 23 07 00.
- C. Duct Connectors:
 1. Flange Connectors
 - a. Refer to flange reinforced transverse joint system described under duct construction above. Flanged connections to system components other than adjacent duct sections may be fabricated similar to a transverse joint. If required to connect to equipment or components of different configuration provide flanged connector custom fabricated of reinforcement shapes as specified.
 - b. Material: Match adjacent duct.

2. Flexible Connectors - Duct to Equipment:

- a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Ductmate Industries, Inc.
 - 2) Duro Dyne Inc.
 - 3) Ventfabrics, Inc.
 - 4) Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- b. Provide factory fabricated flexible connectors with heavy gauge metal edge bands double roll crimped each side onto water, flame-retardant, mildew resistant, NFPA approved flexible fabric connector strip.
- c. Metal Edge Bands: 2 strips of 2-3/4 inches wide, 0.028-inch- thick G90 galvanized sheet or stainless steel, or 0.032-inch- thick aluminum sheets. Provide same metal and corrosion resistance as connected ducts.
- d. Fabric Connector Strip: minimum 3-1/2 inches wide, 20 oz. per square yard fiberglass fabric strip double coated with neoprene (general service), hypalon (outdoors), nitrile (chemical resistant service similar to fume hoods), or silicone (high temperature service similar to kiln or engine exhaust).
- e. Coatings and Adhesives: Comply with UL 181, Class 1.

3. Electrical Bonding Connectors:

- a. Provide complete system of electrical bonding across all electrical discontinuities resulting from non-conducting duct work components. Refer to section 26 05 26 - Grounding and Bonding of Electrical Systems.

D. Airflow Adjusters:

1. Single Blade Volume and Splitter Dampers:

- a. Construction per SMACNA Duct Manual and as noted below.
- b. Materials: Match associated duct corrosion resistance requirements.
- c. Provide double wall airfoil blade dampers where duct velocity is over 1000 fpm nominal.
- d. Maximum blade width 12 inches.
- e. Multiple dampers or manufactured multi-blade damper above 600 square inches duct cross section.

f. Bearings and Adjusters:

- 1) Heavy duty quadrant adjusters with 12 gauge offset handle, captive bolt/wing nut lock in 2" minimum radius slot, split clamp with bolt on 3/8" shaft up to 300 square inch duct, 1/2" shaft for duct up to 600 square inch cross section.
- 2) Closed end bearings for duct rated for 2" WG and above.
- 3) Standoff under quadrant placing quadrant outside of specified duct insulation. Insulate between duct and quadrant.
- 4) When occurring in acoustically lined ducts, install with insulated "build-outs" per Duct Manual.

2. Multi-blade Manual Volume Dampers:

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- 1) Air Balance Inc.; a division of Mestek, Inc.
- 2) American Warming and Ventilating; a division of Mestek, Inc.
- 3) Flexmaster U.S.A., Inc.
- 4) McGill AirFlow LLC.
- 5) Nailor Industries Inc.
- 6) Ruskin Company.
- 7) Trox USA Inc.
- 8) Vent Products Company, Inc.

b. Materials: Match associated duct corrosion resistance requirements.

c. Standard leakage rating.

d. Suitable for horizontal or vertical applications.

e. Frames:

- 1) Hat-shaped channels 0.064-inch minimum thickness.
- 2) Mitered and welded corners.
- 3) Flanges for attaching to walls and flangeless frames for installing in ducts.

f. Blades:

- 1) Opposed-blade design standard unless otherwise noted.
- 2) Stiffen damper blades for stability.
- 3) Formed single thickness blades allowed up to 1000 feet per minute (fpm) design duct velocity; provide airfoil blades above 1000 fpm.
- 4) Galvanized-steel, 0.064 inch thick.

g. Blade Axles: full length of damper blades, bearings at both ends of operating shaft.

- h. Bearings: Oil-impregnated bronze, molded synthetic, or stainless-steel sleeve bearing as applicable.
- i. Tie Bars and Brackets: Galvanized steel.
- j. Damper Hardware:
 - 1) Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
 - 2) Include center hole to suit damper operating-rod size.
 - 3) Include elevated platform for insulated duct mounting.
- k. Jackshaft:
 - 1) Provide as required for adjusting multi section multi-blade dampers simultaneously.
 - 2) Size: 1-inch diameter.
 - 3) Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
 - 4) Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

E. Duct Access Control:

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following. Note not all manufacturers offer all products:
 - a. American Warming and Ventilating; a division of Mestek, Inc.
 - b. Carnes.
 - c. Cesco Products; a division of Mestek, Inc.
 - d. Ductmate Industries, Inc.
 - e. Flame Gard, Inc.
 - f. Flexmaster U.S.A., Inc.
 - g. Greenheck Fan Corporation.
 - h. KEES, Inc.
 - i. Lloyd Industries, Inc.
 - j. Metal Form Manufacturing, Inc.
 - k. McGill AirFlow LLC.
 - l. 3M
 - m. Nailor Industries Inc.
 - n. Price Industries.
 - o. Ventfabrics, Inc.
 - p. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

2. General Purpose Duct-Mounted Service Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."
 - a. Door:
 - 1) Double wall, rectangular.
 - 2) Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - 3) Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
 - 4) Fabricate doors airtight and suitable for duct pressure class.
 - b. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
 - c. Number of Hinges and Locks:
 - 1) Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
 - 2) Access Doors up to 18 Inches Square: Two hinges and two sash locks.
3. Grease Duct or Type I Cooking Hood Exhaust Duct Access Door:
 - a. UL 1978 listed, meets NFPA 96 standards.
 - b. Twin layer 11 gauge (0.120-inch) panels, same steel as duct.
 - c. Minimal protrusion into duct, no more than inner door thickness.
 - d. Inner panel with profiled access opening welded to duct interior, with welded on studs.
 - e. Outer door hinged to duct with full coverage ceramic gasket rated for 2300 deg F.
 - f. Hinge welded to duct, screwed to outer completely removable for cleaning panel.
 - g. Tool free access: perimeter studs with wing nuts.
 - h. Center handle folds flat under insulation.
 - i. Provide with extension bolts/coupling nuts or extended studs and UL listed reusable insulation cover and plate.
4. Grease Duct or Type I Cooking Hood Exhaust Duct Access Panel:
 - a. UL 1978 listed, meets NFPA 96 standards.
 - b. Twin layer 11 gauge (0.120-inch) panels, same steel as duct.
 - c. Minimal protrusion into duct, no more than inner door thickness.
 - d. Ceramic board gasket rated for 2300 deg F covers entire outer door.
 - e. Tool free access with center and perimeter studs with wing nuts.
 - f. Easily removable for cleaning.
 - g. Center handle folds flat under insulation.
 - h. Provide with extended studs and UL listed reusable insulation cover and plate.
5. Instrument Test Access Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

2.9 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Water-Based Joint and Seam Sealant:
 - 1. Application Method: Brush on.
 - 2. Solids Content: Minimum 65 percent.
 - 3. Shore A Hardness: Minimum 20.
 - 4. Water resistant.
 - 5. Mold and mildew resistant.
 - 6. VOC: Maximum 75 g/L (less water).
 - 7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 - 8. Service: Indoor or outdoor.
 - 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- C. Flanged Joint Sealant: Comply with ASTM C 920.
 - 1. General: Single-component, acid-curing, silicone, elastomeric.
 - 2. Type: S.
 - 3. Grade: NS.
 - 4. Class: 25.
 - 5. Use: O.
 - 6. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 7. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- E. Round Duct Joint O-Ring Seals:
 - 1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
 - 2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
 - 3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.10 HANGERS AND SUPPORTS

- A. Provide complete system of Air Duct Hangers and Supports as required by the Air Duct systems included. Refer to Section 23 05 29 – “Hangers and Supports for HVAC Components” for details of Hanger and Support requirements for Air Ducts and associated components.
- B. Provide complete system of Air Duct Vibration and Movement Control as required by the Air Duct systems included. Refer to Section 23 05 43 – “Mechanical Vibration and Movement Control” for details of vibration isolation and movement control requirements for Air Ducts and associated components.
- C. Provide complete system of seismic restraint as required by the project conditions and Air Duct systems included. Refer to Section 23 05 48 – “Mechanical Seismic and Wind Load Control” for details of seismic restraint requirements for Air Ducts and associated components.
- D. Flexible Duct Supports and Accessories:
 - 1. Elbow Supports: UL listed for plenum installation molded fiber reinforced plastic elbow support at connections to ceiling mounted devices designed to maintain tension in flex duct and eliminate collapsed elbows. Basis of design: Thermaflex FlexFlow elbows.
 - 2. Flexible Duct Supports: UL listed for plenum installation molded fiber reinforced plastic 1-1/2” wide straps adjustable for 4” to 16” diameter flex duct, supports duct without damaging vapor barrier or collapsing soft insulation or duct. Basis of design: Thermaflex FlexTie straps.
 - 3. Clamps: Re-usable stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size, or single use “zip-tie” strap of plenum rated plastic, sizes 3 through 10 inches diameter maximum.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions under which duct work is to be installed for compliance with requirements for proper installation.
 - 1. Check all drawings for detailed information and locations and field verify all conditions affecting installation.
 - 2. Notify Architect in writing of any conditions detrimental to proper and timely installation.
 - 3. Obtain Architect’s approval before fabrication of any changes in size required by obstructions and job conditions.
 - 4. Proceed with installation only after unsatisfactory conditions have been corrected in an acceptable manner.
 - 5. Beginning installation constitutes Contractor’s acceptance of substrates and conditions.

3.2 DUCT FABRICATION

- A. Fabricate and install as shown on Drawings and in manner coordinated with all construction requirements.
- B. Sizes shown on plans are clear inside duct dimensions representing the design hydraulic radius of the duct. Generally, fabricate ductwork of sizes shown on plans. During field verification, confirm that duct of aspect ratio shown fits within general construction constraints coordinated with all other trades. Adjust aspect ratio, joint spacing, reinforcement, etc., as required during coordination process to fit duct of equivalent hydraulic radius where shown. If duct of reduced hydraulic radius is required due to field conditions, submit RFI for direction before proceeding.
- C. Flexible Connections: Provided at intake and discharge connections to all motor powered fan air handling equipment and other vibration isolated air handling component connections.
- D. Fabricate all ductwork to the SMACNA pressure classification reinforcement standards shown on the drawings and to the following minimum standards.
 - 1. Conform to special duct pressure classification requirements for all duct between air handler blowers and last fire or fire/smoke damper in series, and duct after the last fire or fire/smoke damper in series up to the next 90 deg. turn:
 - a. Fabricate to the SMACNA pressure classification reinforcement standards required by the system supply or return blower dynamic stall pressure; assume the larger of 200% of external operating pressure scheduled or 150% of fan total pressure listed as a minimum. VIF with approved equipment fan curves and adjust pressure classification values accordingly.
 - 2. Where there are no fire or fire / smoke dampers and past the 90 degree turn mentioned above, complete to the last branch duct volume damper, VAV box, induction unit, or other pressure restricting device, fabricate duct to pressure classification as required by the system supply or return operating pressure listed on the drawings, minimum plus or minus two (2) inch water column.
 - 3. Fabricate branch run-out duct between the last pressure restricting device and the air terminal register, grille, or diffuser to minimum plus or minus one (1) inch water column pressure classification.
- E. Deliver and store all duct with duct interior clean and all openings sealed with film designed for the purpose of keeping uninstalled duct clean. Unless section of duct is being actively extended during construction, keep all openings and RGD properly sealed and prevent entrance of dust, dirt, construction debris, etc.
- F. Extend all access openings, damper rods, and levers to outside of external insulation for convenience of operation and maintenance.
- G. Provide all necessary transitions, fittings, aspect ratio changes, etc., as required to install duct work. Where aspect ratio changes are required to fit within structural or other existing construction constraints, provide duct of equal or larger hydraulic radius.

3.3 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install concealed in general construction unless otherwise specified or indicated on Drawings.
- C. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- D. Provide all necessary openings, sleeves, hanger inserts, chases, recesses, etc., in general construction work. Coordinate duct openings provided by others in ample time to avoid delays.
- E. Provide collars to trim all duct openings in general construction work.
- F. Make final ductwork connections to equipment where indicated on the drawings.
- G. Install ductwork in all spaces as high as possible and in locations to avoid interference with recessed lights, piping, general construction, etc.
- H. Install round ducts in maximum practical lengths.
- I. Install ducts with fewest possible joints.
- J. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- K. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- L. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- M. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- N. Route ducts to avoid passing through transformer vaults, electrical equipment rooms and enclosures, and stairwells.
- O. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- P. Where ducts pass through fire-rated interior partitions and exterior walls, install fire or combination fire-smoke dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.
- Q. Where duct passes through exterior walls and roofs from interior to exterior, provide water and airtight penetration detailing as required, preserving the thermal, moisture, and vapor penetration resistance of the surrounding assembly.

- R. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.4 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds and surrounding heat affected zone to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.5 ADDITIONAL INSTALLATION REQUIREMENTS FOR COMMERCIAL KITCHEN HOOD EXHAUST DUCT

- A. Install commercial kitchen hood exhaust ducts without dips and traps that may hold grease, and sloped up from hood to outlet or down from high point to a grease reservoir as specified, a minimum of 1:48 (2 percent) for horizontal runs up to 75 feet and 1:12 (8.3percent) for runs above 75 feet. Where continuous slope up is not possible,
- B. Install fire-rated access panel assemblies at each change in direction and at maximum intervals of 20 feet in horizontal ducts, and at every floor for vertical ducts, or as indicated on Drawings. Locate access panel on top or sides of duct a minimum of 1-1/2 inches from bottom of duct.
- C. Do not penetrate fire-rated assemblies except as allowed by applicable building codes and authorities having jurisdiction.

3.6 DUCT SEALING

- A. Make system air tight / water tight as required and approved, replacing any poor joints or careless work. Fabricate ductwork to the following SMACNA leakage standards:
 - 1. Seal Class A - Greater than 2 inch w.g. and for air and water tight ductwork described below.
 - 2. Seal Class B – 2 inch w.g. and less general supply, return, and exhaust ductwork.

3.7 HANGER AND SUPPORT INSTALLATION

A. Comply with the requirements of the following:

1. SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
2. Section 23 05 29 – Hangers And Supports for HVAC Components.
3. Section 23 05 43 – Mechanical Vibration and Motion Control.
4. Section 23 05 48 - Mechanical Wind Load Control.

B. Comply with the additional requirements below:

1. SMACNA load tables do not provide for external loads on duct: provide for 200 lb external load on all duct hangers and supports. Increase hanger and support sizes from SMACNA tables accordingly:
 - a. Minimum band size 20ga. x 1 inch.
 - b. Duct 48" wide and larger; provide trapeze style support of metal channel framing or angle iron, suspended from threaded rods.
 - c. Hanger bands to extend down sides and turn under bottom 1 inch minimum for all duct sizes. Minimum (2) #10 sheet metal screws per hanger (one each on side and bottom), (2) screws minimum on sides for duct over 12 inches tall, 12 inches on center max.
2. Hangers Exposed to View:
 - a. Rectangular duct: threaded rod and angle or channel supports.
 - b. Round duct: twin half round bands 14 ga min., and threaded rods.
3. Provide hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
4. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
5. Do not allow flexible duct to rest on general construction. Support flexible duct at maximum 3 feet on center.

3.8 CONNECTIONS

A. Make connections at all intake and discharge connections between duct and vibration producing equipment with fans, including BCU, AHU, RTU, FCU, etc., where duct passes through building expansion joints, and as shown on the drawings, with flexible connectors as specified.

1. Round connections: Adhesive and approved metal draw bands; ends tightly bolted together.

2. Rectangular flanges: Material securely held in grooved seam, tightly clipped or screwed on 6 inch centers.
3. Connections not over 2 inch between duct and equipment, with at least 1 inch excess material.
4. Install neatly so as not to interfere with air flow through connection. Provide round metal center ring or rectangular metal center collar to prevent flex fabric collapse inside of nominal connected duct dimensions.
5. Provide complete electrical continuity of duct systems to ground, bridging all flexible duct connectors and other non-conductive duct with grounding jumpers as described in section 26 05 26 – Grounding and Bonding of Electrical Systems.

B. Registers, Diffusers, and Grilles:

1. Install flexible duct connections to registers, diffusers, and grilles with no more than 20 degree unsupported bend in flex. Where horizontal duct connects to vertical axis collar (ex., ceiling mounted diffuser), provide elbow support as specified or hard elbow.
 - a. Where flexible duct is not electrically continuous between metallic duct and Register, Grille, or Diffuser as specified in section 26-05-26 - Grounding and Bonding of Electrical Systems, provide with grounding conductor or jumper as specified, maintaining continuity between RGD and ductwork.
2. Exposed, duct side mounted: Mount outlet outside of air stream with extension collars full size of register or grille frame outside margin, with turned in duct flange and turned out terminal mounting flange. Provide vaned air extractor with internal mechanism / external rotating knob adjuster.
3. Exposed ductwork hard piped connections: per Duct Manual.

3.9 PAINTING

- A. Paint interior of ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 painting Sections.

3.10 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Duct System Cleanliness Tests:
 1. Visually inspect duct system to ensure that no visible contaminants are present.
 2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."

- a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.
- C. Electrical Bonding Continuity Testing: Test each entire Ductwork and Ductwork Accessories system for ground bonding continuity in accordance with section 26 05 26 - Grounding and Bonding of Electrical Systems. Include test report demonstrating approvable bonding as part of commissioning and closeout documentation.
- D. Duct system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.11 DUCT CLEANING

- A. Clean new and existing duct system(s) before testing, adjusting, and balancing.
- B. Use service openings for entry and inspection.
 - 1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Division 23 Section "Air Duct Accessories" for access panels and doors.
 - 2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
 - 3. Remove and reinstall ceiling to gain access during the cleaning process.
- C. Particulate Collection and Odor Control:
 - 1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
 - 2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.
- D. Clean the following components by removing surface contaminants and deposits:
 - 1. Air outlets and inlets (registers, grilles, and diffusers).
 - 2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
 - 3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
 - 4. Coils and related components.

5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.12 START UP

- A. Air Balance: Comply with requirements in Section 23 05 93 - "Testing, Adjusting, and Balancing for HVAC."

END OF SECTION 23 31 00

SECTION 23 33 00 - DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Fire Dampers,
 - 2. Exhaust Hoods.
 - 3. Machinery Safety Guards.

1.3 PERFORMANCE REQUIREMENTS

- A. Provide Ductwork Accessories in compliance with all applicable requirements of Section 23 31 00 – Ductwork and appropriate design and construction manuals issued by Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA)
- B. Fabricate accessories able to withstand the forces imposed by the support and restraint system.
- C. Provide dampers of sizes shown on plans (inside duct dimensions).
- D. Fire Dampers: Provide dampers listed for the application in locations shown on Drawings or specified in this Section including all new ducts penetrating fire rated general construction and in accordance with NFPA 90A maintaining the fire rated integrity of the general construction.
- E. Fabricate Exhaust Hoods used for contaminant (dust, fume, smoke, chips, etc...) removal or control in accordance with applicable NFPA requirements, the industrial ventilation requirements of both SMACNA and the American Conference of Governmental Industrial Hygienists Industrial Ventilation Manual, and any additional requirements of these contract documents.
- F. Machinery Safety Guards: Provide machinery safety guards in compliance with UL, OSHA, and NYS Department of Labor requirements for all machinery included in Heating Work Prime Contract. Equipment manufacturers' guards are preferred: provide shop fabricated machinery safety guards where guards are not supplied by equipment manufacturer.

1.4 ACTION SUBMITTALS

- A. Product Data: For all Ductwork Accessories, as required demonstrating compliance with specified requirements.

- B. Shop Drawings: For all Ductwork Accessories. Include plans, elevations, sections, details and attachments to other work.
 - 1. Detail Ductwork Accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Additionally include the following as required for specific applications:
 - a. Fire-damper installations: include sleeves, duct-mounted access door locations, and motorized damper operators.
 - b. Exhaust Hoods: include sub-frame mounting requirements and adjustment mechanisms.
 - c. Machinery Safety Guards: include detailed operating and service clearance dimensions.
 - 2. Wiring Diagrams: For power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Ductwork Shop and Coordination Drawings: Include Ductwork Accessories in Ductwork Shop Drawings and Ductwork Coordination Drawings, only after approval of ductwork accessories submittals detailed in this section. Refer to Section 23 31 00 – Ductwork for details.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Comply with all applicable codes and as follows.
- B. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- C. Fire, Smoke, and Combination Fire – Smoke Dampers: Rated, listed, and labeled according to UL 555 and UL 555S by an NRTL.
- D. Kitchen Hood Service: Comply with NFPA 96 "Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations" and UL 710 "Standard for Safety Exhaust Hoods for Commercial Cooking Equipment".
- E. Comply with AMCA 500-D testing for damper rating.

1.8 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fusible Links: Furnish the larger of 10 percent of amount installed, or minimum 3.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General Material Requirements:

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated.
2. Provide sheet metals per mill specs and free of pits, voids, seam or roller marks, stains, discolorations, inadvertent bends and kinks, and other imperfections.

- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M, G90 coating designation, lock forming quality, unless otherwise specified..

1. Exposed to view, not externally insulated or painted: Galvannealed steel.
2. Exposed to view, to be painted: Galvannealed steel prepared for painting via mill phosphatizing and subsequent heat treatment in accordance with ASTM D6386 and ASTM D7803 as applicable

- C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304L or 316L Stainless-Steel Sheets; cold rolled, annealed. Minimum surface finish for concealed duct No. 2B exterior of duct, No. 2D interior of duct. Minimum surface finish for duct exposed to view in occupied spaces, No. 4 polish.

- D. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

- E. Industrial Arts or Technical Shop duct and hood fabrication where called for: ASTM A 1008/A 1008M Carbon-Steel Sheets, with matte finish for exposed ducts, prepared for painting in accordance with Section 23 05 00 – “General Requirements for HVAC” and Division 9 sections on painting.

- F. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

- G. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

2.2 CONTROL DAMPERS

- A. Refer to Section 23 09 00 – Instrumentation and Control for HVAC for control damper specifications.

2.3 FIRE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Air Balance Inc.; a division of Mestek, Inc.
 - 2. Arrow United Industries; a division of Mestek, Inc.
 - 3. Cesco Products; a division of Mestek, Inc.
 - 4. Greenheck Fan Corporation.
 - 5. Metal-Fab Inc.
 - 6. Nailor Industries Inc.
 - 7. NCA Manufacturing, Inc.
 - 8. Prefco; Perfect Air Control, Inc.
 - 9. Ruskin Company.
 - 10. Vent Products Company, Inc.
 - 11. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Provide curtain-blade or multi-blade dampers as required by size and application.
- C. Type: Dynamic rated and labeled according to UL 555 and/or UL 555S by an NRTL.
 - 1. Rated for ducts up to 4-inch wg static pressure class and 4000-fpm velocity.
 - 2. Mounting Orientation: Vertical or horizontal as required by application.
 - 3. Include blade lock and stainless-steel closure spring sufficient for Mounting Orientation.
- D. Fire Rating: 1-1/2 or 3 hours as required; refer to drawings for fire rating of general construction.
- E. Frame: Fabricated with roll-formed, 0.034-inch- thick galvanized or stainless steel; with mitered and interlocking corners. Provide frame Type “C” unless otherwise specified or shown on drawings and materials as specified and detailed in Part 3 - Execution.
 - 1. Type “A”: Frame sized to fit inside adjacent ductwork dimensions with retracted / open blades and frame in airstream.
 - 2. Type “B”: Curtain type with retracted blades outside of adjacent ductwork dimensions and remainder of frame sized to fit inside adjacent ductwork dimensions.
 - 3. Type “C”: 100% free area curtain style with frame and retracted blades outside airstream.
 - 4. For dampers shown or required by general construction conflicts to be installed with damper blades outside of the plane of the fire resistive general construction, provide factory assembly UL listed for this installation including extended reinforced sleeve factory covered with fire rated insulation meeting or exceeding the rating of the surrounding general construction.

- F. Mounting Sleeve: Factory- or field-installed, same steel as frame.
1. Minimum Thickness: equal to the thicker of the attached duct material, 0.052 inches, or as required by product listing, and of length to suit the associated wall or floor construction.
 2. Provide with (4) 1-1/2 inch X 1-1/2 inch, 14 gauge galvanized steel mounting angles to be field attached to the sleeve only.
 3. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
- G. Blades: Roll-formed, interlocking, 0.034 inch thick sheet steel of same type as frame. In place of interlocking blades, use full-length steel blade connectors.
- H. Heat-Responsive Device: Replaceable fusible links rated for 165 deg F or other temperature where noted on drawings.

2.4 EXHAUST HOODS

- A. Point Source Semi-Flexible Exhaust Arms:
1. Smooth bore and exterior, self-supportive semi-flexible exhaust hose arm that can easily be maneuvered by the operator to the desired location, and not spring back from selected position. Include conical bell-mouth entry hood of flame retardant and impact resistant plastic. Stiff enough to extend minimum 6 diameters horizontally without sagging, capable of retaining bend radius equal to no more than 1.5 diameters. Similar to Car-mon WXS-076 with wall bracket.

2.5 EXHAUST HOODS (PAINT HOOD WITH ROLL FILTER)

- A. General Requirements:
1. Duct material, thickness and joints as required for gases and vapors involved and per current NYS code, NFPA, SMACNA, and Industrial Ventilation Manual requirements.
 2. Hoods to project at least 6 inch beyond contaminant generating equipment or as otherwise shown on drawings or required by Industrial Ventilation Manual.
 3. Provide continuous internal channel brackets as required for supporting lighting fixtures.
- B. Tabletop paint capture hood:
1. Fume hoods are in a Standard lengths are designed to fit 58" welding booths. The hood is fabricated of minimum 20 gauge galvanized steel. The baffles between slots are cross broken for greater strength and are installed using fasteners suitable to facilitate removal for cleaning and repositioning to enhance intake velocity, if necessary. The hood is completely factory assembled with crimped and beaded discharge collar for secure and air tight duct connection. Provide filter frame brackets. Similar to Car-mon FH-58

a. Paint Pre-Filter roll:

- 1) Manufacturer: Car-mon to match hood.
- 2) Filter thickness: 1"
- 3) Merv Rating: 7
- 4) Material: Polyester
- 5) Provide filter frame to secure to hood with fastening knobs.

2.6 MACHINERY SAFETY GUARDS

A. Provide for all machinery furnished, modified, or used by this contractor:

1. In compliance with UL, OSHA, and NYS Department of Labor requirements, where a hazard to personnel exists from moving parts.
2. Where guard is not supplied by equipment manufacturer, or is missing or inadequate for existing equipment.
3. Galvanized steel or expanded metal, reinforced and constructed as shown in Duct Manual.
4. Mount to avoid vibration transmission from equipment.
5. With holes and cover plates for speed checks.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where air terminal units are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories with stainless steel fire and fire-smoke dampers in aluminum ducts.
- C. Install control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated. Install in a flanged configuration with duct flanges bolted to damper frame, square and without wracking or binding, properly sealed to the duct as required to maintain the duct and damper rated leakage rate without compromise.
- D. Install fire dampers according to UL listing and in compliance with the latest edition of NFPA 90A.

1. Provide for adequate perimeter clearance and fire rated flexible infill as required, in accordance with the manufacturers instructions and so as to not cause interference with the operation of the damper due to restricted thermal expansion.
 2. Provide Type C frame dampers, or, increase damper size in each dimension by an amount such that the free opening is the specified duct size minimum, and provide duct transitions on either side. Example: 12" x 20" duct with Type A 7/8 inch frame and nominal damper size 1/4 inch less than listed duct with blades protruding 3 inches into duct - use 17" x 20" Type A damper.
 3. For all fire and fire/smoke dampers installed in duct, plenum casing, or other building construction openings which must be fire rated, with nominal cross section dimensions in width or height greater than the manufacturer's maximum available dimensions, provide multiple dampers and all interceding support structure as required to fabricate a U.L. listed fire damper assembly of the required free area cross section.
 4. Provide access door(s) in duct and building construction where required for access for each damper in suitable locations to permit reasonable access to and resetting of the damper blades. Demonstrate access and resetting of thermal linkage during commissioning.
- E. Install exhaust hoods in accordance with drawing details and manufacturer's instructions. Adjust as required in the field to correct height, level as required, in readily serviceable locations.

3.3 FIELD QUALITY CONTROL

- A. Tests and Inspections:
1. Operate all dampers to verify full range of movement.
 2. Operate fire damper to verify full range of movement and verify that proper heat-response device is installed.
 3. Demonstrate proper service access at all dampers.
 4. Inspect installation of all exhaust hoods. Demonstrate proper function under intended use.

END OF SECTION 23 33 00

SECTION 23 34 00 - HVAC FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Utility set fans.
 - a. Welding arm exhaust fan
 - b. Paint hood exhaust fan
 - 2. Centrifugal roof ventilators.
 - 3. Upblast propeller roof exhaust fans.
 - 4. Dryer vent booster fan.

1.3 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base fan-performance ratings on actual Project site elevations.
- B. Operating Limits: Classify according to AMCA 99.

1.4 SUBMITTALS, GENERAL

- A. General: Submit all action submittals and informational submittals required by this Section concurrently.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:
 - 1. Certified fan performance curves with system operating conditions indicated.
 - 2. Certified fan sound-power ratings.
 - 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 4. Material thickness and finishes, including color charts.
 - 5. Dampers, including housings, linkages, and operators.
 - 6. Roof curbs.
 - 7. Fan speed controllers.

- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.

1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
 - 1. Roof framing and support members relative to duct penetrations.
 - 2. Ceiling suspension assembly members.
 - 3. Size and location of initial access modules for acoustical tile.
 - 4. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

1.7 CLOSEOUT SUBMITTALS

- A. Field quality-control reports.
- B. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.8 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.
- C. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for commercial kitchen exhaust shall also comply with UL 762.

1.9 COORDINATION

- A. Coordinate size and location of structural-steel support members.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided.
- C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.10 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Belts: One set(s) for each belt-driven unit.

PART 2 - PRODUCTS

2.1 UTILITY SET FANS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Breidert Air Products.
 - 2. Carnes Company.
 - 3. Hartzell Fan Incorporated.
 - 4. Loren Cook Company.
 - 5. New York Blower Company (The).
 - 6. PennBarry.
 - 7. Trane; a business of American Standard Companies.
- B. Housing: Fabricated of galvanized steel with side sheets fastened with a deep lock seam or welded to scroll sheets.
 - 1. Housing Discharge Arrangement: Adjustable to eight standard positions.
- C. Fan Wheels: Single-width, single inlet; welded to cast-iron or cast-steel hub and spun-steel inlet cone, with hub keyed to shaft.
 - 1. Blade Materials: Steel.
 - 2. Blade Type: Backward inclined, Forward curved or Airfoil.
 - 3. Spark-Resistant Construction: AMCA 99, Type B.
- D. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
- E. Shaft Bearings: Prelubricated and sealed, self-aligning, pillow-block-type ball bearings with ABMA 9, L₅₀ of 200,000 hours.
 - 1. Extend grease fitting to accessible location outside of unit.
- F. Belt Drives:
 - 1. Factory mounted, with final alignment and belt adjustment made after installation
 - 2. Service Factor Based on Fan Motor Size: 1.5.
 - 3. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
 - 4. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
 - 5. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.
- G. Accessories:
 - 1. Inlet and Outlet: Flanged.

2. Companion Flanges: Rolled flanges for duct connections of same material as housing.
3. Backdraft Dampers: Gravity actuated with counterweight and interlocking aluminum blades with felt edges in steel frame installed on fan discharge.
4. Access Door: Gasketed door in scroll with latch-type handles.
5. Scroll Dampers: Single-blade damper installed at fan scroll top with adjustable linkage.
6. Inlet Screens: Removable wire mesh.
7. Drain Connections: NPS 3/4 threaded coupling drain connection installed at lowest point of housing.
8. Weather Hoods: Weather resistant with stamped vents over motor and drive compartment.
9. Discharge Dampers: Assembly with opposed blades constructed of two plates formed around and to shaft, channel frame, sealed ball bearings, with blades linked outside of airstream to single control lever of same material as housing.
10. Variable Inlet Vanes: With blades supported at both ends with two permanently lubricated bearings of same material as housing. Variable mechanism terminating in single control lever with control shaft for double-width fans.
11. Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
12. Vibration Isolators:
 - a. Type: Spring isolators.
 - b. Static Deflection: 1"
13. Spark Arrestance Class: B.

2.2 ROOFTOP CENTRIFUGAL EXHAUST FANS

- A. Unit Description: UL listed exhaust fan specifically designed for outdoor installation and service, shipped fully assembled and factory tested prior to shipment.

1. Housing:
 - a. Spun 16 gauge minimum weather tight marine grade aluminum two piece upper housing, with reinforced rolled edges. Down-blast, up-blast type housing as scheduled.
 - 1) Where scheduled, provide low profile louvered penthouse style rectangular housing as specified in section 23 37 00 – Air Inlets and Outlets, complete with hinged base with retention cables.
 - b. Quick release stainless steel latches to provide access to motor compartment without use of tools.

- c. Fully welded aluminum curb cap
 - d. Rubber grommets internal wiring passages unless otherwise specified.
 - e. Provide aluminum nameplate riveted to housing exterior with manufacturer, model, cfm, static pressure, and electrical characteristics all permanently engraved or stamped.
2. Impellers: Backward inclined, non-overloading, statically and dynamically balanced all aluminum construction, including hubs. Impeller shall overlap a spun aerodynamic inlet cone. Belt or direct drive as shown on Drawings.
3. Power Assemblies:
- a. Motor and drive isolated from discharge air stream in forced-air cooled compartment.
 - b. Power Assembly mounted on minimum 14 gauge plated steel structure, supported on housing with rubber isolators loaded in combination shear and compression.
 - c. Belt drive systems:
 - 1) Drive Sheaves: Cast iron, adjustable with machined grooves.
 - 2) Impeller Shaft: Anti-corrosion treated with re-lubricable pillow block style ball bearings rated for L-50 200,000 hr life at maximum cataloged operating speed under conditions of service.
 - 3) Drive Belts: premium notched belts, sized for 1.5 times motor horsepower. Provide spare belt, secured to dome of motor compartment.
 - d. Motors:
 - 1) Refer to Section 23 05 13 Common Electrical requirements for HVAC Components for additional information.
 - 2) Constant Speed Operation: Open drip-proof type with sealed, permanently lubricated ball bearings; pre-wired through to disconnect switch mounted under fan cover with sufficient legs to break all leads to motor.
 - a) Motors, wiring, and disconnects serving fume hood exhaust fans and other potentially flammable exhaust streams shall be UL listed and in accordance with NEC for explosion proof construction.

- b) Single Phase: Electronically commutated motor (ECM) as manufactured by General Electric. Motor shall be of permanent magnet, brushless DC premium efficiency design with variable speed electronic controller capable of maintaining constant speed, torque, and/or cfm as required by service, capable of accepting 0-10vdc or 4-20mA speed control signal from building management system. Adjustable slow start and gradual speed changes, permanently lubricated ball bearings, and extra quiet operation are all included.

4. Accessories / options as scheduled:

- a. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
- b. Bird Screen: Removable, 1/2-inch mesh, aluminum or brass wire.
- c. Motorized Dampers: Parallel-blade dampers mounted in ductwork below curb base with electric actuator; wired to close when fan stops. Refer to Section 23 09 00 for damper specifications.
- d. Factory fabricated insulated roof curb meeting the requirements above and of Section 23 05 29 – Hangers and Supports for HVAC Components.
- e. Spray hood exhaust fans: Constructed of special corrosion-resistant materials with factory-applied anti-stick epoxy coating in color as selected by Architect. Configure for up-blast operation. Configuration shall include weather-proof factory wired junction box and disconnect switch mounted to the housing exterior, 18 inch high ventilated roof curb, floating hinge kit, and UL listed for the scheduled application.
- f. Food Service Applications: Configure up-blast fans to meet requirements of NFPA 96. Configuration shall include weather proof factory wired junction box and disconnect switch mounted to the housing exterior, grease collector and separator box, 18 inch high ventilated roof curb, Floating hinge kit and UL 762 listed.
- g. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.

5. Manufacturers: Cook, Greenheck, Penn Ventilator, Twin Cities, or Approved Equal.

2.2 UPBLAST PROPELLER ROOF EXHAUST FANS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Acme Engineering & Manufacturing Corporation.
 - 2. Breidert Air Products.
 - 3. Carnes Company.
 - 4. Greenheck Fan Corporation.
 - 5. Hartzell Fan Incorporated.

6. Loren Cook Company.
 7. New York Blower Company (The).
 8. PennBarry.
- B. Wind Band, Fan Housing, and Base: Reinforced and braced aluminum, containing aluminum butterfly dampers and rain trough, motor and drive assembly, and fan wheel.
1. Damper Rods: Steel with nylon bearings.
 2. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.
- C. Fan Wheel: Replaceable, extruded-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.
- D. Belt Drives:
1. Resiliently mounted to housing.
 2. Weatherproof housing of same material as fan housing.
 3. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 4. Shaft Bearings: Prelubricated and sealed, self-aligning, pillow-block-type ball bearings.
 5. Pulleys: Cast-iron, adjustable-pitch motor pulley.
 6. Motor Mount: On outside of fan cabinet, adjustable base for belt tensioning.
- E. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
1. Configuration: Self-flashing without a cant strip, with mounting flange.
 2. Overall Height: 12 inches.
 3. Sound Curb: Curb with sound-absorbing insulation.
 4. Pitch Mounting: Manufacture curb for roof slope.
 5. Metal Liner: Galvanized steel.
 6. Mounting Pedestal: Galvanized steel with removable access panel.

2.3 INLINE DRYER VENT BOOSTER FAN

- A. Manufacturers:
1. Basis of design: Fantech Inc.
 2. Or approved equal
- B. Unit Description:
1. Listed to the supplement of UL705
 2. Inlet Diameter: 4 inches.
 3. Outlet Diameter: 4 inches.
 4. Casing Diameter: 9-11/16 inches.
 5. Inlet and Outlet Connection Collars: 1 inch.
 6. Casing Material: Galvanized Metal with air-tight, folded seam construction. A housing joined with screws or rivets is unacceptable.

7. Motors: External-rotor AC motor.
8. Integral pressure switch for altitude range of 0-10,000 ft above sea level
9. Motor Protection: Thermal overload protection with automatic reset.
10. Air Temperature Limit Safety Cutoff: Integral thermal fuse
11. Voltage: 120 V.
12. Frequency: 50/60 Hz.
13. Nominal Voltage Range: 100 to 130 V.
14. Phase: 1.
15. Maximum Airflow: 161 cfm.
16. RPM: 2,601
17. Power Rating, Motors: 69 W.
18. Current: 0.58 A.
19. Operational Temperature: max 167 degrees F.
20. Weight: 13.3 lbs.
21. Motor Insulation Class: B.
22. Motor Enclosure Class: IP44.

C. Accessories

1. Secondary lint trap
2. Model: similar to "DBLT4W"
3. Inlet Diameter: 4 inches
4. Outlet Diameter: 4 inches
5. Weight: 2.3 lbs.

2.4 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Electrical Requirements for HVAC Equipment."
1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
- B. Enclosure Type: Totally enclosed, fan cooled.

2.5 SOURCE QUALITY CONTROL

- A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 INSTALLATION

- A. Install power ventilators level and plumb.
- B. Secure roof-mounted fans to roof curbs with cadmium-plated hardware. See Division 07 Section "Roof Accessories" for installation of roof curbs.
- C. Install units with clearances for service and maintenance.
- D. Label units according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

3.3 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Ductwork."
- B. Install ducts adjacent to power ventilators to allow service and maintenance.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 3. Verify that cleaning and adjusting are complete.

4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 5. Adjust belt tension.
 6. Adjust damper linkages for proper damper operation.
 7. Verify lubrication for bearings and other moving parts.
 8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
 10. Shut unit down and reconnect automatic temperature-control operators.
 11. Remove and replace malfunctioning units and retest as specified above.
- C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Prepare test and inspection reports.

3.5 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
- D. Replace fan and motor pulleys as required to achieve design airflow.
- E. Lubricate bearings.

END OF SECTION 23 34 00

SECTION 23 37 00 – AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Interior Outlets and Inlets:
 - a. Registers, grilles, and diffusers
 - 2. Exterior Outlets and inlets:
 - a. Roof Top hoods
 - b. Air louvers

1.3 SYSTEM DESCRIPTION

- A. Design Requirements
 - 1. Registers, Grilles, and Diffusers: Provide all supply, return and exhaust grilles, registers, and diffusers required for all systems.
 - 2. Roof Top Hoods: Provide fresh air intake and exhaust / relief openings, as shown or specified in Contract Documents. Cross- reference dimensions of each penthouse/ hood shown on heating drawings with those on the architectural drawings. Notify architect in writing of any discrepancies prior to submitting on equipment.
 - 3. Air Louvers: Provide AMCA-rated louvers for all fresh air intake and exhaust openings, except as otherwise shown or specified in Contract Documents. Cross- reference dimensions of each louver shown on heating drawings with those on the architectural drawings. Notify architect in writing of any discrepancies prior to submitting on louvers.

1.4 PERFORMANCE REQUIREMENTS

- A. Interior Outlets and Inlets: Provide outlets and inlets with aspiration ability, temperature mixing, and velocity traverses and decay with distance, throw, pressure drop, and noise criteria ratings equal to or better than specified products.

1.5 SUBMITTALS

- A. Comply with requirements of SECTION 01 33 00 - Submittals and as modified below.
- B. Product Data: Submit manufacturer's product literature, technical specifications, performance data, installation instructions, and similar information required to demonstrate compliance with specified requirements. Annotate all selected options, cross referenced to specification and drawing designations. Include tabulated data for all proposed outlets and inlets, showing size, type, cfm, aspiration ability, water entrainment, temperature mixing, and velocity traverses and decay with distance, throw, pressure drop, noise criteria ratings and any other applicable data demonstrating performance equal to or better than specified products.
- C. Shop Drawings: Submit shop drawings showing sizes, construction details, mounting details, capacity, and air flow characteristics for all equipment. Include complete tabulated schedules as indicated below for each of RGD, Louvers, and roof Top Hoods / Louvered Penthouses.
 - 1. Registers, Grilles, and Diffusers (RGD): Include complete tabulated schedule showing locations for each RGD, type, size, capacity as shown on Drawings, and performance data for each RGD furnished, including throw and noise criteria ratings. Indicate selections on data.
 - 2. Roof Top Hoods and Louvers: Include complete tabulated schedule showing locations for each Roof Top Hood and Louver showing type, size, wall and/or roof rough opening size, capacity as shown on Drawings, and performance data for each including pressure drop and water entrainment specifications. Include all this data on coordination drawings and special Mechanical Penetrations of General Construction Envelope coordination drawing.
- D. Contract Closeout Submittals: Comply with requirements of SECTION 01 77 00, including submission of operating and maintenance instructions as item in "Operating and Maintenance Data" manual described in that section.

1.6 SEQUENCING AND SCHEDULING

- A. Deliver Exterior Outlets and Inlets (Roof Top Hoods and Louvers) to project in sufficient time for installation in walls as wall construction progresses.
 - 1. Coordinate unit selection to meet requirements of other equipment and installation details (automatic dampers, back draft dampers, etc.).
 - 2. Verify all opening sizes, locations and mounting arrangements prior to installation.

PART 2 - PRODUCTS

2.1 REGISTERS, GRILLES, AND DIFFUSERS

A. General

1. Provide registers, grilles, and diffusers with border systems that are compatible with adjacent wall and ceiling systems, and that are specifically manufactured to fit into ceiling modules with accurate fit and adequate support. Refer to general construction drawings and specifications for details of adjacent systems.
2. All performance criteria equal to or better than design make as specified and tagged on drawings.
3. Provide factory baked white enamel finish for steel materials and clear or color anodizing for aluminum material as base bid standard finish unless otherwise specified or noted.
4. Provide products by one of the following:
 - a. Krueger or equal.
 - b. Price or equal.
 - c. Anemostat or equal.

B. Registers:

1. TYPE "R-A": Double deflection wall supply register; vertical front and horizontal rear vanes with 3/4" spacing between blades, rubber gasket to prevent streaking, vanes individually adjustable; extruded aluminum construction, clear anodized finish. Similar to Krueger "5880V", "5880H (horizontal front)", "R5880" (round duct register with mounting as shown and as required).

C. Grilles

1. TYPE "G-A": Eggcrate return grille; 1/2 inch x1/2 inch x1inch deep squares; fabricated aluminum core; flat frame; white baked enamel finish to match ceiling. Neck size and accessories as noted on drawings. Provide frame to fit lay-in ceiling grid or hard ceiling as required. Similar to Krueger "EGC-15".
2. TYPE "G-B": Single deflection wall return grille; vertical or horizontal vanes, fixed at 0 degrees or 35 degrees (as noted on drawings), with 3/4 inch spacing between blades; aluminum or steel construction as required to match adjoining ductwork. Similar to Krueger "S80" or "S580".

D. Supply Diffusers:

1. TYPE "D-A": Ceiling air diffuser with stamped steel construction, stamped three ring removable core, 24 inch square face, 4 way pattern, integral round neck of size as noted on drawings. Anti smudge design to prevent streaking. Flush T-bar mount to fit lay-in ceiling grid, coordinate with G.C. Similar to Krueger "1400".
2. TYPE "D-B": Linear ceiling or side wall supply diffuser of extruded aluminum slotted construction. Provide extruded aluminum frames to match ceiling types shown on architectural drawings, with fully concealed plaster flush mount frame in gypsum ceilings. Provide end frames for individual and end applications, butt cut with alignment pins for tandem end to end applications as shown. Provide four slots, 1 inch wide slots with one or two way throw and number of slots indicated by adjacent flow arrows on drawings. Provide adjustable internal blades capable of both pattern and flow adjustment, from horizontal to vertical downblast. Provide sound lined insulated supply plenum with round tap (duct size indicated on drawings) where shown connected to duct, and with blank off strips and no internal adjusters where shown not connected to duct. Design make: Krueger "1900-#". Other acceptable manufacturers of equivalent product include Titus, Price, Nailor and Anemostat.

2.2 ROOF TOP HOODS

A. Dome Style Roof Top Hoods:

1. Rated for snow and wind load shown on Code Compliance Drawings.
2. Designed for intake or exhaust (relief), as shown on the drawings.
 - a. Intake hoods shall have minimum free area at inlet equal to twice the throat cross section.
 - b. Exhaust hoods shall have minimum free area at outlet equal to the throat cross section.
 - c. Provide closed cell insulation adhered to underside of exhaust /relief hoods to prevent condensation.
3. Heavy gauge (0.060 inch) aluminum construction.
4. All vertical seams continuously welded. Tops stressed and sloped for drainage with standing lock-formed seams; slope by cross breaking only of flat top not acceptable. All mechanical fasteners stainless steel.
5. Provide hinged joint between hood and base for ease of service access.
6. Provide 1/2 inch aluminum bird screen, secured in removable frame to underside of opening.
7. Curb: Install units on minimum 12 inch high insulated curb or higher curb as scheduled; factory fabricated similar to Pate "Model PC-5A".

8. Size and capacity as shown on the drawings.
 - a. Provide scheduled factory finish as detailed below:
 - 1) Standard mill finish.
9. Provide products by one of the following:
 - a. Cook "G" series or equal.
 - b. Greenheck "Fabra Hood" or equal.
 - c. Twin City Fans and Blowers, "MG" series or equal.

B. Gooseneck Style Roof Top Hoods

1. Factory or shop fabricate according to SMACNA's "HVAC Duct Construction Standards" and as otherwise detailed on drawings, with gooseneck riser outside curb, minimum 4 inches larger each way than curb throat dimensions.
2. Heavy gauge (0.060 inch) aluminum construction. Any mechanical fasteners stainless steel.
3. Curb: Provide factory fabricated curb as specified in Section 23 05 29, minimum 12 inches high.
4. Bird Screening: Aluminum, 1/2-inch- square mesh, 0.063-inch wire or Stainless-steel, 1/2-inch- square mesh, 0.047-inch wire.
5. Capacities, size and Characteristics as indicated on drawings.

2.3 AIR LOUVERS

A. Thinline Construction Requirements:

1. Factory constructed aluminum louvers with storm resistant blades of performance equal to or better than the design make.
2. Frame and blades constructed of extruded aluminum, alloy 6063-T5. Nominal wall thickness of 0.060 inches, depth to be 1-1/2 or 2 inches as noted in schedule.
3. Blade angle of 45 degrees, centered nominally at 1-7/8 inches for the 1-1/2 inch deep and at 3-3/16 inch for 2 inch deep louvers. Hidden vertical supports shall allow continuous line appearance.
4. Stainless Steel 1/2 inch mesh x 0.063 inch bird screen secured in a removable frame with SS tamperproof fasteners, on exterior face of louver. Finish same as louver.
5. Provide sill, jamb and head flashing extensions as required for weather tight installation, same material and finish as louver, in style selected by Architect.
6. Provide welded construction for all factory assembled louver components. Provide stainless steel fasteners for all field assembled components.

7. Size, type and location as shown on drawings.
8. Provide scheduled factory finish as detailed below:
 - a. Kynar: Provide factory applied and baked resin based paint coating, minimum 70% fluoropolymer (PVDF) similar to Kynar 500 or Hylar 5000 as manufactured by the Valspar Corporation. Coating shall meet all performance requirements of AAMA 2605 and ASCA 96. Color as selected by Architect from manufacturer's full range of standard or premium colors including minimum 16 "standard" colors and 12 "premium" colors.
9. Provide products by one of the following, with performance as scheduled:
 - a. Basis of Design: Greenheck
 - b. Reliable
 - c. Ruskin

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Examine conditions under which air outlets and inlets are to be installed and notify a Architect in writing of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in an acceptable manner.
 1. Air Louvers: Coordinate unit selection to meet other equipment and installation details (automatic dampers, back draft dampers, etc.). Verify all opening sizes, locations and mounting arrangements prior to installation.

3.2 INSTALLATION

- A. Install air outlets and inlets in strict accordance with manufacturer's recommended installation instructions for applications shown on Drawings.
- B. Registers, Grilles and Diffusers (RGD): Install all RGDs in accordance with manufacturer's installation instructions and SMACNA installation manual at locations indicated on Drawings.
 1. Adjust each type of RGD as required to achieve even air distribution throughout occupied space, generally free of objectionable drafts and dead air pockets. Demonstrate adjustments of distribution to Owner and additionally adjust as requested by Owner's representative during or subsequent to initial adjustments. As RGD adjustment and Testing and Air Balancing work affect each other, make preliminary adjustment to all RGDs prior to balancing, and make final RGD adjustment during TAB work in cooperation with TAB agency. Refer to section 23 05 93 – TESTING, ADJUSTING, AND BALANCING FOR HVAC for more detail.

2. Provide final balancing in accordance with SECTION 23 05 93.
3. Furnish to Owner, with receipt, 3 operating keys for each type of air outlet and inlet that requires them.

C. Roof-Mounted Hoods

1. Provide roof curbs in sufficient time to coordinate with construction schedule.
2. Verify all opening sizes, locations, and mounting arrangements prior to installation. Provide structural support frame around all roof deck penetrations 12 inches x 12 inches and larger, unless specifically indicated otherwise elsewhere on the Contract Documents..
3. Comply with applicable requirements of SECTION 23 05 29 – Hangers and Supports for HVAC Components.
4. Comply with manufacturer's requirements for securing to curbs. Use appropriate weather proof gasketing and stainless steel fasteners as required meeting loading requirements specified above.

D. Air Louvers: Comply with manufacturer's specifications and recommendations for assembly and installation of air louver units, hardware, operators, and other components.

1. Set units plumb, level, and true to line, without warp or rack of frames. Anchor securely in place. Separate aluminum and other corrodible metal surfaces from sources of corrosion or electrolytic action at points of contact with other materials. Use stainless steel fasteners.
2. Make suitable provision for thermal expansion in assembly of groups of units.
3. Set head, jamb, and sill members in bed of compound as shown, or with joint fillers or gaskets as shown to provide weather tight construction.
4. Provide suitable gaskets or coating where dissimilar metals are in contact.
5. Clean aluminum surfaces promptly after installation of units. Remove excess glazing and sealant compounds, dirt, and other substances. Lubricate hardware and other moving parts.

END OF SECTION 23 37 00

SECTION 23 45 00 – DUST COLLECTION SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Dust collectors and accessories.

1.2 SYSTEM DESCRIPTION

A. Requirements

1. Provide high efficiency dust collector system and accessories of the construction, type, size, and capacity as specified, scheduled, and shown on the drawings. Including at least the following:
 - a. Dust collector and fan
 - b. Silencer, Pre-Filter and HEPA filter for recirculation of air
 - c. All support structures.
2. Provide a system of ductwork to include main exhaust trunk, connections to collector unit, branch drop to shop equipment to be served as shown on the drawings, and discharge air arrangement as specified and shown on the drawings.
3. Provide all wall openings, equipment supports, and associated patching and sealing required for installation of system.
4. Provide complete system conforming to the stricter of the applicable requirements listed in latest editions of the following:
 - a. New York State Department of Labor, Industrial Code Rules 12 and 18.
 - b. American Conference of Governmental Industrial Hygienists Industrial Ventilation Manual.
 - c. Equipment manufacturer's recommended installation instructions and as required for listing.
5. All wiring, on collector side of single point of power connection, to be provided by Mechanical Contractor.

1.3 SUBMITTALS

- A. Comply with requirements of SECTION 01 30 00 - Submittals and as modified below.**

B. Product Data

1. Dust Collectors: Provide complete data on collector unit including all dimensions, operating characteristics, electrical characteristics, construction details, installation requirements, and certified V.S./ S.P. curve for collector clearly depicting system operating range.
2. Provide operating information for all equipment including pressure drop of HEPA filter unit, silencer, abort valve and all other air handling equipment at the design airflows as well as note clean and dirty condition.

C. Shop Drawings

1. Dust Collectors

- a. Provide 1/2 inch scale drawings of complete system within 30 days following award of contract, including:
 - 1) Complete plan view of entire system including equipment served.
 - 2) Showing adequate sections and elevations.
 - 3) Indicating dimensions of all equipment, ductwork, and accessories to be installed.
 - 4) Indicating all dampers, hoods, connections, etc.
- b. Provide complete schedule of equipment served indicating machine type, description and size, branch duct size, minimum air volume (in CFM) for each branch, size and type of each equipment hood.
- c. Provide airflow/pressure drop calculations for the system clearly indicating losses assumed at machine, duct losses, dust collector, HEPA filter, silencer and other losses. Verify that equipment provided will operate at design.

D. Provide complete data on collector unit, including all dimensions, operating characteristics, certified performance curve for collector clearly depicting system operating, range electrical characteristics, construction details, and installation requirements. Reference appropriate standards certifying compliance.

E. Contract Closeout Submittals: Comply with requirements of SECTION 01 70 00, including submission of operating and maintenance instructions as item in "Operating and Maintenance Data" manual described in that section.

PART 2 - PRODUCTS

2.1 FILTER TUBE TYPE DUST COLLECTOR

A. General:

1. Furnish and install, where shown on the plans, a high efficiency filter type dust collector.

2. Unit shall have all construction and performance standards of the design make as a minimum.
3. Interior and exterior carbon steel surfaces shall be painted with one (1) coat of heat cured powder spray or interior and exterior primed with rust inhibitive red oxide and finish coated with exterior grade alkyd resin enamel paint. All surfaces of shop or field fabricated welds or accessories shall be painted to match with the factory standard paint and colors.

B. Dust Collector:

1. Dust collector shall be self-cleaning fabric type complete with cotton filters, backward inclined blower, motorized shaker, factory wired controller and external discharge silencer. Manufacturer's literature shall state that dust collector and selected filter spacing is designed for the collection of wood dust.
2. Dust collector shall be airtight, all steel construction with sealed seams and gasketed quick opening doors with 1/4 turn knobs. Housing shall be fabricated from minimum of 14-gage mild steel. Unit shall consist of a filter section and a funnel bottom section without slide gates or doors to allow downflow of dust directly into 55 gallon drum assembly furnished by manufacturer.
3. Unit to include a multi-pocket filter module, which is sewn from 8-ounce cotton sateen fabric designed to deliver in excess of 99.5% efficiency by weight on industrial dusts. The filter module shall have rigid insert separators to prevent collapse of filters and loss of the effective filter area. Flat shaker fingers located at the bottom of the filter module shall prevent adjoining pockets from touching one another and blanking off. The filter pocket spacing shall be of the wide spacing type (1-1/2 inch) to permit the collected dust to be shaken off the filters freely as recommended by the manufacturer for the collection of wood dust. Fabric media with narrow spacing or pleated cartridges will not be accepted. Total airflow to filter fabric area (air to cloth ratio) shall not exceed 8 CFM per square foot at the design cfm.
4. Each filter module shall be secured in place by two lever operated over-center, locking mechanisms to assure a positive seal and allow for easy removal of filters without tools.
5. Filters will be cleaned automatically after a fifteen second delay following the shutdown of the blower, by the oscillating action delivered by the motorized eccentric driven shaker assembly, which imparts a vibratory force throughout the entire surface of each individual filter pocket to dislodge the dust. Shaker motor shall be 1/3 HP.
6. Operation of the automatic shaker shall be controlled by a solid state, dual mode timer with adjustable shaker cycle range from 1.8 - 180 seconds. Magnetic starters with overload relays for the blower and shaker motor and control transformer shall be factory wired in a NEMA 4 control panel mounted on the unit for single point wiring. Also included shall be a push button station for remote mounting.
7. Dust collectors shall be protected by explosion vents designed in accordance with NFPA 68. or have a listed explosion suppression system designed in accordance with NFPA 69.

C. Blower:

1. Blowers shall be integral AMCA Type C direct drive type of the size, performance, and efficiency specified as a minimum, secured to its own motor. Blower performance shall be tested and certified according to AMCA Standard 210. The blower assembly shall be dynamically balanced prior to shipment.
2. Blower shall be located on the outlet (clean air) side of the filters.
3. Blower wheel shall be of backward inclined blade design, of non-sparking cast and machined aluminum, housed in a welded steel scroll.
4. Motors shall be 7 HP, 3 phase, voltage 208/3/60 or as otherwise scheduled on electrical drawings, continuous heavy duty cast iron construction, premium efficiency, TEFC, class F insulation, standard NEMA frame with bearings rated for direct drive fan service, and shall have at minimum a 1.15 service factor. Direct drive motors shall be 3450 RPM maximum. Motor efficiency shall meet New York State energy code requirements.
5. Exterior units shall have motor and drive protected from wind driven icing conditions by a steel rain cap.

D. Silencer: Provide factory silencer on discharge of motor (24x18x36)

E. Hopper:

1. Provide a single 55 gallon drum hopper for the collection and storage of the wood chips and dust. Provide adapter caps to drum fitted with heavy duty flex hose.

F. Support Stand:

1. The collector support stand shall be constructed of welded and bolted structural steel sections and steel plate, certified for the weight of the collector, hopper, duct work, and all accessories.
2. Support stand shall have minimum clear inside dimensions as required to individually remove collection drums from an installation in the configuration shown on the drawings.

G. Operating and Capacity Data:

1. See schedule for information.

H. Accessory Devices:

1. Unit shall be equipped with an exhaust particulate rated sound attenuator. Provide support framework to rigidly secure sound attenuator to unit.
2. Provide combination motor starter including on/off/auto switch, pilot light and one locking remote start-stop station with two emergency panic "off" buttons located within the two shops served as required. Coordinate location of remote start and emergency off stations with architect and Owner in field. Conspicuously label.

3. Provide control panel with either UL or ETL labeled wiring in conformance with 508A. Control panels not labeled by dust collector manufacturer shall be labeled, in field, by a certified UL or ETL representative, prior to placing equipment in operation. Contractor shall provide fused safety disconnect switch as single point of power connection.

I. Basis of design: Sternvent Vibraclean Model DKPD 24405

2.2 RECIRCULATION AIR FILTER SECTION

- A. Provide Pre-Filters: (1) 30/30 pleated 24"x24"x2".
 1. Manufacturer: Aire-Loc, Camfil Farr or approved equal
- B. Provide (1) 2000 High capacity H.E.P.A. filters 24"x24"x12".
 1. Manufacturer: Aire-Loc, Camfil Farr or approved equal
- C. Provide Filter Housing for pre-filters and H.E.P.A filters rated for exterior use.
 1. Manufacturer: Aire-Loc SAHB-2-1H1W-WP, Camfil Farr or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions (by Installer): Examine conditions under which dust collectors are to be installed and notify Prime Contractor in writing of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION

- A. Install all components of dust collector and collector protection systems with manufacturer's representative providing supervision of installation of complete system and all components. System must be installed in accordance with all of the manufacturer's installation requirements, tested and commissioned by a factory-trained technician before placing the system in operation.
- B. Install ducts in accordance with the requirements of other Div 23 specifications.
 1. Provide all necessary openings and patch and seal as shown on Drawings or otherwise required for proper installation of system.
 2. Ductwork construction including metal thickness and reinforcing to withstand no less than -10" w.c.
 3. Provide for class A sealing of all ductwork.

3.3 FIELD QUALITY CONTROL

A. Testing:

1. Dust Collector System: Arrange for inspection and approval of system by dust collector manufacturer employed field commissioning representative prior to third party testing. Provide for testing and balancing of air flow rates by TAB agency. Test complete system for adequacy of dust collection in presence of collector manufacturer's representative and Owner's authorized personnel under actual woodworking and fume generating conditions.
2. Submit test reports for approval including machine type, description and size, branch duct size, minimum air volume (in CFM) for each branch, size and type of each equipment hood, and Owner's subjective performance rating for all pickup points. Reports to be signed by Contractor, Manufacturer's representative, and Owner's representative.

B. Demonstration and Training: Provide for contractor and dust collector manufacturer employed field commissioning representative demonstration of system.

1. Instruct Owner's personnel in operation and maintenance of complete system, including pickup hoods, duct and connections, dust collector unit, storage bin, silencer, deflagration suppression system, and any after filters.
2. Submit letter attesting to training agenda and completion of itemized instruction, signed by owner's representative.

END OF SECTION 23 45 00

SECTION 23 51 00 - BREECHINGS, CHIMNEYS, AND STACKS**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Listed double-wall vents.

1.3 SUBMITTALS, GENERAL

- A. General: Submit all action submittals and informational submittals required by this Section concurrently.

1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Special gas vents.
- B. Calculations: For each venting system, provide stack calculations generated by vent manufacturer's computerized calculation software, demonstrating appropriate venting conditions. Accompany calculations with letter by authorized representative of boiler manufacturer on their letterhead stating venting system as designed is approved for the boiler system proposed.
- C. Shop Drawings: For vents, breechings, chimneys, stacks, and special flashings. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, methods of field assembly, components, hangers and seismic restraints, and location and size of each field connection.
 - 2. For installed products indicated to comply with design loads, include calculations required for selecting seismic restraints and structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITALS

- A. Welding certificates.

1.6 CLOSEOUT SUBMITTALS

- A. Warranty: Special warranty specified in this Section.

1.7 QUALITY ASSURANCE

- A. Source Limitations: Obtain listed system components through one source from a single manufacturer.
- B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code--Steel," for hangers and supports and AWS D9.1/D9.1M, "Sheet Metal Welding Code," for shop and field welding of joints and seams in vents, breechings, and stacks.
- C. Certified Sizing Calculations:
 - 1. Venting and Boiler Manufacturer shall certify venting system sizing calculations.
 - 2. Include boiler operating data as approved and recommended by Boiler Manufacturer, actual field dimensions measured by Contractor, and actual fitting and duct losses as certified by Vent Manufacturer.
 - 3. Assume an average winter ambient temperature of 20 degrees F, an average winter indoor temperature of 70 degrees F, and boilers operating at the typical design return and supply water conditions indicated on the drawings.
 - 4. Perform and present calculations demonstrating negative breeching pressure as required to avoid combustion product backflow through smallest appliance when it is off and all other appliances are at high fire, and also with all appliances at high fire demonstrating that back pressure is within proper operating range of boiler's common venting requirements.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of venting system that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, structural failures caused by expansion and contraction.
 - 1. Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LISTED SPECIAL GAS VENTS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Secure Seal
 - 2. Heat-Fab, Inc.
 - 3. Metal-Fab, Inc.
 - 4. Selkirk Inc.; Selkirk Saf-T Vent CI Plus.
- B. Description: Double-wall metal vents tested according to UL 1738 rated for continuous firing at up to 550 deg F with gas or propane.
- C. Listed for ANSI category I, II, III, or IV appliances, with positive or negative flue pressure complying with NFPA 211.
- D. Construction: Inner shell and outer jacket separated by at least a 1 inch airspace.
- E. Inner Shell: ASTM A 959, Type 29-4C stainless steel.
- F. Outer Jacket: Stainless steel.
- G. Accessories: Tees, elbows, guy wire collar, appliance connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.

2.2 CONDENSATE PIPE AND FITTINGS

- A. CPVC Plastic Pipe: ASTM F 441/F 441M, Schedules 40 and 80, plain ends as indicated in Part 3 "Piping Applications" Article.
- B. CPVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM F 438 for Schedule 40 pipe; ASTM F 439 for Schedule 80 pipe, long radius pattern.
- C. Condensate Neutralizing Tank: Provide each condensing boiler system with at least one condensate neutralizing tank. The total number of neutralizing tanks may be based on installation convenience or as specifically shown, with the neutralizing tank(s) size as follows: larger of two gallons or 1.5 gallon per million BTU/hr boiler input capacity (volume measured below level of boiler condensate trap outlet). Condensate neutralizing tank constructed of 4" or 6" diameter schedule 40 PVC pipe assembly with threaded condensate inlet and outlet connections, a threaded side cleanout cover, and supports. Fill with appropriately sized limestone gravel. Provide limestone gravel as required to fill all neutralizing tanks, plus 5 gallons extra per boiler room; leave extra in lidded 5 gallon pail for Owner's future use. Pipe neutralizing tank with unions for service removal, extend outlet to floor drain.

D. Solvent Cements for Joining Plastic Piping:

1. CPVC Piping: ASTM F 493.

- a. Use CPVC solvent cement that has a VOC content of 490 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- b. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), in contrasting color.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 APPLICATION

- A. Listed Special Gas Vent: Condensing gas appliances.
- B. Condensate Piping: for use with high efficiency category IV appliances only where manufacturer's installation instructions include PVC or CPVC vent and condensate drain piping.

3.3 INSTALLATION OF LISTED VENTS AND CHIMNEYS

- A. Locate to comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.
- B. Seal between sections of positive-pressure vents according to manufacturer's written installation instructions, using sealants recommended by manufacturer.
- C. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.
- D. Slope breechings down in direction of appliance, with condensate drain connection at lowest point piped through condensate neutralizing kit to nearest drain.
- E. Lap joints in direction of flow.
- F. Join sections with acid-resistant joint cement to provide continuous joint and smooth interior finish.
- G. Connect to rear discharge boilers with 45 degree elbow and lateral tee with bottom cleanout where space permits.

- H. Join horizontal breeching to vertical stack using a boot tee (or lateral high efficiency tee (similar to lateral 45 degree tee plus a 45 degree elbow if required to maintain neutral to negative pressure as specified) with drip ring above and cleanout below.
- I. Erect stacks plumb to finished tolerance of no more than 1 inch out of plumb from top to bottom.

3.4 CLEANING

- A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.
- B. Clean breechings internally, during and after installation, to remove dust and debris. Clean external surfaces to remove welding slag and mill film. Grind welds smooth and apply touchup finish to match factory or shop finish.
- C. Provide temporary closures at ends of breechings, chimneys, and stacks that are not completed or connected to equipment.

END OF SECTION 23 51 00

SECTION 23 52 16 - CONDENSING BOILERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes packaged, factory-fabricated and assembled, gas fired, fire-tube condensing boilers, trim, and accessories for heating water.

1.3 SUBMITTALS, GENERAL

- A. General: Submit all action submittals and informational submittals required by this Section concurrently.

1.4 ACTION SUBMITTALS

- A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: Power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Source quality-control test reports.
- B. Warranty: Special warranty specified in this Section.

1.6 CLOSEOUT SUBMITTALS

- A. Field quality-control test reports.
- B. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.
- C. Warranty: Executed special warranty specified in this Section.

1.7 QUALITY ASSURANCE

- A. Provide all boilers/burners in accordance with applicable requirements of New York State Labor Department Industrial Code Rule No. 4 (cited as 12 NYCRR4) and Code Rule No. 14 (cited as 12 NYCRR14).
- B. Provide all boilers/burners in accordance with applicable requirements of New York State Education Department Manual of Planning Standards.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.
- E. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."
- F. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."
- G. UL Compliance: Test boilers for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.
- H. I=B=R Performance Compliance: Condensing boilers must be rated in accordance with applicable federal testing methods and verified by AHRI as capable of achieving the energy efficiency and performance ratings as tested within prescribed tolerances.
- I. Do not allow boilers to be operated unsupervised until all operating and safety controls have been verified as properly installed and tested as properly functional.

1.8 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 23 05 00.

1.9 WARRANTY

- A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents. Provide parts and labor warranty covering the complete boiler installation: at no additional charge, correct all defects in workmanship and materials reported within (1) year from the date established on certificate of substantial completion.

- B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Fire-Tube Condensing Boilers:

- a. The pressure vessel/heat exchanger shall carry a 15 year from shipment, non-prorated, limited warranty against any failure due to condensate corrosion, thermal stress, mechanical defects or workmanship.
- b. The pressure vessel is warranted against failure due to thermal shock for the lifetime of the boiler provided the boiler is installed, controlled, operated and maintained in accordance with the operation and maintenance manual.
- c. The burner shall be conditionally guaranteed against any failure for (5) five years from shipment.
- d. Manufacturer labeled control panels are conditionally warranted against failure for (3) three years from shipment.
- e. All other components, with the exception of the igniter, flame detector and O₂ sensor, are conditionally guaranteed against any failure for (2) two years from shipment.

1.10 MAINTENANCE SERVICE

- A. Provide factory authorized service as outlined in Part 3 of this specification for a minimum of one year from date established on certificate of substantial completion.
- B. Provide factory authorized maintenance service as required to maintain the boiler and burner system in good operating order at no additional charge for one (1) year from date established on certificate of substantial completion. In addition to initial start-up, a full tune up is required at the start of the first heating season and additionally within one month of the end of this one year service period. Combustion and thermal performance at eleven month tune up must be equal to or better than those set at initial start-up, with combustion reports printed directly off an electronic combustion analyzer. Include all parts and labor, including maintenance parts kits normally required for 24 month tune-up (gasket kit, ignition rods or electrodes as required, etc.).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Basis of Design: Benchmark Platinum with Edge (ii) control - AERCO International.
 2. Bosch Buderus SB Series
 3. Superior Boiler - Creek Series

4. Simons Boilers - FTC Titan
5. Or approved equal

- B. Due to differences in size and access clearances, piping connections, working pressures, burner configuration, venting, sequencing, etc..., proposed use of boilers other than the basis of design Boilers and Burners scheduled will require detailed review of required changes and incorporation of this into boiler room shop drawings and design. Refer to Instructions to Bidders, General Conditions, Division 1, and section 23 05 00 – Common Work Results for HVAC, for additional provisions and requirements relating to specified equivalent, proposed equivalent, or substitution products.

2.2 FIRE-TUBE CONDENSING BOILERS

- A. Description: Natural gas fired, fully condensing, fire tube design. Power burner shall have full modulation (the minimum firing rate shall not exceed 100,000 BTU/HR input. Boilers that have an input greater than 100,000 BTU/Hr at minimum fire will not be considered) and discharge into a positive pressure vent. Boiler efficiency shall increase with decreasing load (output), while maintaining setpoint. Boiler shall be factory-fabricated, factory-assembled and factory-tested, fire-tube condensing boiler with heat exchanger sealed pressure-tight, built on a steel base, including insulated jacket, flue-gas vent, combustion-air intake connections, water supply, return and condensate drain connections, and controls.
- B. Heat Exchanger: The heat exchanger shall be constructed of 439 stainless steel fire tubes and tubesheets, with a one-pass combustion gas flow design. The fire tubes shall be 1/2" or 5/8" OD, with no less than 0.049" wall thickness. The upper and lower stainless steel tubesheet shall be no less than 0.25" thick. The pressure vessel/heat exchanger shall be welded construction. The heat exchanger shall be ASME stamped for a working pressure not less than 150 psig. Access to the tubesheets and heat exchanger shall be available by burner and exhaust manifold removal. Minimum access opening shall be no less than 8 inch diameter.
- C. Pressure Vessel: Maximum water volume of 58 gallons. The boiler water pressure drop is shall not exceed 3 psig at 170 gpm. The boiler water connections are to be 4-inch flanged 150-pound, ANSI rated. The pressure vessel to be constructed of SA53 carbon steel, with a 0.25-inch thick wall and 0.50-inch thick upper head. Inspection openings in the pressure vessel to be in accordance with ASME Section IV pressure vessel code. The boiler shall be designed so that the thermal efficiency increases as the boiler firing rate decreases.
- D. Modulating Air/Fuel Valve and Burner: The boiler burner shall be capable of the following firing turndown ratios without loss of combustion efficiency or staging of gas valves. The turndown ratios shall be as follows and are based on BTU size:
1. BMK2500: 15:1

2. The burner shall not operate above 7.5% oxygen level or 55% excess air. The burner shall produce less than 13 ppm of NO_x, under standard calibration, corrected to 3% excess oxygen when firing on natural gas. The burner shall be metal fiber mesh covering a stainless steel body with spark or proven pilot ignition and flame rectification. All burner material exposed to the combustion zone shall be of stainless steel construction. There shall be no moving parts within the burner itself. A modulating air/fuel valve shall meter the air and fuel input. The modulating motor must be linked to both the gas valve body and air valve body with a single linkage. The linkage shall not require any field adjustment. A variable speed cast aluminum pre-mix blower shall be used to ensure the optimum mixing of air and fuel between the air/fuel valve and the burner.

- E. Minimum Boiler Efficiencies: Minimum boiler efficiencies are be as follows at a 20 degree delta-T:

EWT	100% Fire	40% Fire	5% Fire
160 °F	85.3%	85.7%	86.3%
120 °F	86.6%	87.8%	90.2%
60 °F	94.2%	96.9%	99%

- F. Exhaust Manifold: Corrosion resistant cast aluminum or 316 stainless steel with an 8-inch diameter flue connection. The exhaust manifold to have a collecting reservoir and a gravity drain for the elimination of condensation.
- G. Blower: Variable-speed, DC centrifugal fan to operate during the burner firing sequence and pre-purge the combustion chamber.
1. Motors: Comply with requirements specified in Division 23 Section "Common Electrical Requirements for HVAC Equipment."
 - a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- H. Gas Train: Combination gas valve with manual shutoff and pressure regulator.
- I. Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision.
- J. Combustion Air Filter: The boiler shall be equipped with an automotive high flow air filter to ensure efficient combustion and unhindered burner components operation.
- K. Casing:
1. Jacket: Sheet metal, with snap-in or interlocking closures.
 2. Control Compartment Enclosures: NEMA 250, Type 1A.
 3. Finish: Baked-enamel or Powder-coated protective finish.
 4. Insulation: Minimum 2-inch- thick, mineral-fiber insulation surrounding the heat exchanger.
 5. Combustion-Air Connections: Inlet and vent duct collars.
 6. Mounting base to secure boiler.

2.3 TRIM

- A. Aquastat Controllers: Operating, firing rate, and high limit.
- B. Safety Relief Valve: ASME rated.
- C. Pressure and Temperature Gage: Minimum 3-1/2-inch- diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range.
- D. Boiler Air Vent: Automatic.
- E. Drain Valve: Minimum NPS 3/4 hose-end gate valve.
- F. Safety Relief Valve:
 - 1. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.
 - 2. Description: Fully enclosed steel spring with adjustable pressure range and positive shutoff; factory set and sealed.
- G. Pressure Gage: Minimum 3-1/2-inch diameter. Gage shall have normal operating pressure about 50 percent of full range.
- H. Water Column: Minimum 12-inch glass gage with shutoff cocks.
- I. Drain Valves: Minimum NPS 3/4 or nozzle size with hose-end connection.
- J. Blowdown Valves: Factory-installed bottom and surface, slow-acting blowdown valves same size as boiler nozzle.
- K. Stop Valves: Boiler inlets and outlets, except safety relief valves or preheater inlet and outlet, shall be equipped with stop valve in an accessible location as near as practical to boiler nozzle and same size or larger than nozzle. Valves larger than NPS 2 shall have rising stem.

2.4 CONTROLS

- A. Refer to Division 23 Section "Instrumentation and Control for HVAC."
- B. Boiler operating controls shall include the following devices and features:
 - 1. Control transformer.
 - 2. Set-Point Adjust: Set points shall be adjustable.
 - 3. Operating Pressure Control: Factory wired and mounted to cycle burner.
 - 4. Low-Water Cutoff and Pump Control: Cycle feedwater pump(s) for makeup water control.

5. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to reset supply-water temperature inversely with outside-air temperature. At 0 deg F outside-air temperature, set supply-water temperature at 180 deg F; at 60 deg F outside-air temperature, set supply-water temperature at 120 deg F.
- C. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.
1. High Cutoff: Manual reset stops burner if operating conditions rise above maximum boiler design temperature.
 2. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be automatic reset type.
 3. Auxiliary Low-Water Cutoff Switch: Float and electronic external listed ALWCO piped and wired to prevent burner operation on low water. Cutoff switch shall be manual reset type.
 4. Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.
 5. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.
- D. Building Automation System Interface: Factory install hardware and software to enable building automation system to monitor, control, and display boiler status and alarms.
1. Hardwired Points:
 - a. Monitoring: On/off status, low water level alarm.
 - b. Control: On/off operation, hot water supply temperature set-point adjustment.
 2. A communication interface with building automation system shall enable building automation system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building automation system.

2.5 ELECTRICAL POWER

- A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.
- B. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
1. House in NEMA 250, Type 1 enclosure.
 2. Wiring shall be numbered and color-coded to match wiring diagram.
 3. Install factory wiring outside of an enclosure in a metal raceway.
 4. Field power interface shall be to fused disconnect switch.

5. Provide branch power circuit to each motor and to controls with a disconnect switch or circuit breaker.
6. Provide each motor with overcurrent protection.

2.6 BURNER BOILER ACCESSORIES AND RELATED EQUIPMENT

- A. Products of Combustion Venting: Complete system, ASTM A 959, Type 29-4C stainless steel pipe, vent terminal, thimble, indoor plate, vent adapter, and fittings all complete with sealant, size as shown, confirmed by both boiler and venting manufacturer as appropriate for the installation – refer to Section 23 51 00 for details.
- B. Burner Emergency Switches: Surface mounted for existing construction or flush mounted with recessed box for new construction; all aluminum construction (NEMA 2, drip proof). Includes normally open switches rated for 10 amps at 125 VAC and engraved nameplate marked “TO STOP GAS BURNERS.”
 1. Similar to “Class 9001” with “K-15” operator and “KA1” switch block(s) by Square D.
- C. Condensate Control: Provide each boiler with F&T condensate trap and condensate neutralizing tank. One neutralizing tank per boiler or per boiler system will be acceptable. Neutralizing tank(s) size: larger of two gallons or 1.5 gallon per million BTU/hr boiler input capacity (volume measured below level of boiler condensate trap outlet). Condensate neutralizing tank constructed of 4” or 6” diameter schedule 40 PVC pipe assembly with threaded condensate inlet and outlet connections, a threaded side cleanout cover, and supports. Fill with appropriately sized limestone gravel. Provide limestone gravel as required to fill all neutralizing tanks, plus 5 gallons extra per boiler room; leave extra in lidded 5 gallon pail for Owner’s future use. Pipe neutralizing tank with unions for service removal, extend outlet to floor drain.
- D. Combustion-Air Intake: Complete ducted system in accordance with Sections 23 31 00, and manufacturer’s directions.
- E. Gas Train Vent Terminations: Internally threaded 90 degree angle fitting of cast aluminum or malleable iron construction, with stainless steel insect (between 10 and 16 mesh) screening disc interference fit to elbow in such a manner as to disengage from fitting under blow off design back pressure, allowing full discharge. Free area through screening not be less than free area of required vent pipe size (reducing elbow required). Screen recessed from termination, forming an integral drip and paint protection edge

2.7 SOURCE QUALITY CONTROL

- A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
- B. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.

- C. Allow Owner access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.
 - 1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B. Examine mechanical spaces for suitable conditions where boilers will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.
- D. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 BOILER INSTALLATION

- A. Equipment Mounting: Install boilers on cast-in-place concrete equipment base(s) using elastomeric pads. Comply with requirements for equipment bases specified in Division 23 05 00 Section "Common Work Results for HVAC." Comply with requirements for vibration isolation devices specified in Section 23 05 43 – Mechanical Vibration and Movement Control.
 - 1. Minimum Deflection: 1/4 inch.
 - 2. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.
 - 3. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 - 4. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor into structural concrete floor.
 - 5. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 6. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 7. Install on 4-inch- high concrete base.
- B. Install gas-fired boilers according to NFPA 54.
- C. Assemble and install boiler trim.
- D. Install electrical devices furnished with boiler but not specified to be factory mounted.
- E. Install control wiring to field-mounted electrical devices.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to boiler to allow service and maintenance.
- C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve.
- D. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Division 23 Section "Hydronic Piping."
- E. Connect hot-water piping to supply- and return-boiler tapings with shutoff valve and union or flange at each connection.
- F. Install piping from safety relief valves to nearest floor drain.
- G. Boiler Venting:
 - 1. Install flue venting kit and combustion-air intake.
 - 2. Connect full size to boiler connections. Comply with requirements in Division 23 Section "Breechings, Chimneys, and Stacks."
- H. Condensate control: Pipe all condensate from boiler condensate drains and breeching / chimney condensate and rain drains through appropriately sized traps, then neutralizing tank, to floor drain. Pipe acidic condensate in CPVC, protected from foot traffic by steel pipe sleeve outside carrier pipe, covered with yellow and black striped safety strips, secured to floor to prevent rolling.

3.4 FIELD QUALITY CONTROL

- A. Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections, and to provide startup and commissioning service and reports. Start up to be performed only after complete boiler room operation is field verified to offer a substantial load, and complete system circulation. One-year warranty shall be handled by factory authorized tech.
- B. Notify Architect minimum two weeks in advance of test dates.
- C. Comply with performance requirements indicated, as determined by field performance tests.
 - 1. Repeat tests until results comply with requirements indicated.
- D. Provide analysis equipment required to determine performance.
- E. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems and weather do not produce adequate demand.

- F. Remove and replace malfunctioning components and/or complete units and retest as specified. Adjust, modify, or replace equipment to comply.

3.5 COMMISSIONING

- A. Perform tests and inspections and prepare commissioning report according to manufacturer's written instructions and the below for each of:
 - 1. Installation and pre-startup checks.
 - 2. Boiler Startup, testing and adjusting controls and safeties.
 - 3. Functional Testing.
- B. Complete manufacturer's installation and pre-startup checklist and verify the following. Do not proceed with boiler startup until the complete installation is acceptable to equipment Manufacturer and Installer:
 - 1. Installation is as indicated and specified.
 - 2. Boiler is level on concrete base.
 - 3. Flue and chimney are installed proper size, slope, and without visible damage.
 - 4. Condensate drain from both boiler(s) and chimney is properly installed.
 - 5. Condensate is properly neutralized, drips to floor drain.
 - 6. No damage is visible to boiler jacket, refractory, or combustion chamber.
 - 7. Pressure-reducing valves are checked for correct operation and specified relief pressure. Adjust as required.
 - 8. Clearances have been provided and piping is flanged for easy removal and servicing.
 - 9. Heating circuit pipes have been connected to correct ports.
 - 10. Hydrostatic test. Repair leaks and retest until no leaks exist.
 - 11. Hydronic system is cleaned, flushed, vented, and filled with specified heat transfer fluid to the proper cold fill pressure.
 - 12. Boiler is confirmed as having clean internal hydraulic passageways free of debris settled out during system cleaning.
 - 13. Ensure pumps operate properly.
 - 14. Labels are clearly visible.
 - 15. Boiler, burner, and flue are clean and free of construction debris.
 - 16. Electrical wiring complies with manufacturer's submittal and installation requirements in Division 26 Sections.
 - 17. Controls and safety devices are installed and operational at nominally correct settings.
- C. Boiler Start-up and Controls and Safety Device Checks. Start pumps and boilers and adjust / test safety and operational controls:
 - 1. Operate boilers as recommended or required by manufacturer.
 - 2. Check and record performance of factory-provided boiler protection devices and firing sequences.
 - 3. Check and record performance of boiler fluid-level, flow-switch (optional), and high-temperature interlocks.
 - 4. Check pressure and temperature gages adjustment and function.
 - 5. Check installation and operation of gas pressure regulator device on gas train, including venting. Check, adjust, and record gas pressures.

6. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
 7. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
 8. Verify that control installations are completed.
 9. Adjust burners to maximum operating efficiency over the full firing range.
- D. Functional Testing: After boiler combustion efficiency is adjusted to maximum, perform functional tests measuring and recording the following at low fire, 20, 40, 60, 80, and 100 percent of full capacity.
1. Differential pressure across air / gas orifice.
 2. Combustion-air temperature at inlet to burner.
 3. Flue-gas temperature at boiler discharge.
 4. Flue-gas carbon dioxide, oxygen, and carbon monoxide concentration.
 5. Flue gas NOx emissions where applicable.
 6. Natural flue draft.
 7. Flowrate through each boiler.
 8. Temperature rise through each boiler.
 9. Determine fuel to water efficiency at each test point.
- E. Document and record all test results from installation / pre-functional checklist, startup report and adjustments, and functional testing. Combine into a commissioning report and submit to Architect.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain boilers. Video training sessions. Refer to Division 01 Section "Demonstration and Training."

3.7 WARRANTY PERIOD SERVICE

- A. Provide factory authorized service for a minimum of one year from date established on certificate of substantial completion.
1. Provide service, including 24-hour emergency service, as required to maintain the boiler/burner system in optimum operating order.
 2. Provide the services of a boiler manufacturer factory-employed and trained boiler and burner service and start-up technician for all regular scheduled service and maintenance for the first year following substantial completion. In addition to initial start-up, provide full cleaning, tune up service, and combustion performance adjustment and re-testing within one month of the end of this one year service period. Boiler combustion and thermal performance at end of warranty period tune up must be equal to or better than those set at initial start-up, with combustion reports printed directly off an electronic combustion analyzer. Provide adjustments, repairs, and replacements as required to return boiler to like new performance at this time, including all recommended replacement components.

3. Emergency Service: Provide one year emergency boiler / burner service. If factory employed service technician cannot arrive within 2 hrs of call, contract emergency burner service through an authorized local boiler / burner service organization who can and will respond within 2 hrs to any and all legitimate service calls on a 24 hour / seven day basis, with no charges to the Owner. Factory employed technician to follow-up within 48 hours to insure proper completion of emergency service.

END OF SECTION 23 52 16

SECTION 23 62 13 – UNITARY AIR CONDITIONING EQUIPMENT**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Split System Air Conditioners.
- B. Products Furnished but not Installed Under this Section
 - 1. Associated refrigerant piping and condensate drain piping.

1.3 SYSTEM DESCRIPTION

- A. Design Requirements
 - 1. Cooling performance rated in accordance with ARI Testing.
 - 2. Unit efficiencies meet scheduled performance and exceed Energy Code Requirements.
 - 3. Units listed and labeled by UL and ETL.
 - 4. Provide all refrigeration equipment and related installation in compliance with the latest editions of the Mechanical Code of NYS chapter 11, the safety code for mechanical refrigeration ASHRAE Standard 15, and ANSI Refrigeration Safety Code B 9.1.

1.4 SUBMITTALS

- A. Comply with requirements of SECTION 01 33 00 - Submittals and as modified below.
- B. Product Data: Provide manufacturer's specification data for each unit, showing operating weight, all sizes, dimensions, capacity, operating and performance characteristics, motor horsepower, and other pertinent data including color chart.
- C. Contract Closeout Submittals: Comply with requirements of SECTION 01 77 00, including submission of operating and maintenance instructions as item in "Operating and Maintenance Data" manual described in that section.

PART 2 - PRODUCTS

2.1 DUCTLESS SPLIT HEAT/COOL AIR CONDITIONING UNIT

- A. Unit Description: Unit bearing ARI Certification Symbol and listed by ETL Testing Laboratories, Inc. consisting of outdoor unit which contains refrigerant compressor and can provide cooling only or heating and cooling of spaces, indoor unit connected by insulated copper refrigerant tubing with flare type fittings. System equipped with factory-installed solid core filter drier, large capacity suction accumulator, low ambient controls, and other accessories as specified and as scheduled.
 - 1. Refrigerant Run Capability: 130 feet of lift with maximum tubing length of 130 feet of interconnecting piping for up to 1.5 ton capacity unit, and 50 feet of lift with maximum tubing length of 164 feet for unit with greater than 1.5 ton capacity up to 3.5 ton capacity.
 - 2. Refer to drawings for capacities and performance ratings.
- B. Refrigerant: Sufficient R-32 refrigerant provided in outdoor unit to charge complete system.
- C. Outdoor Condensing Unit: Outdoor with inverter driven variable speed compressors which provides efficient cooling and heating performance.
 - 1. General data:
 - a. Factory assembled and pre-wired with all necessary electronic and refrigerant controls.
 - b. Refrigeration circuit consisting of a digital scroll compressor, motors, fans, condenser coil, electronic expansion valve, solenoid valves, 4 way valve, distribution headers, capillaries, filters, service isolation valves, oil separators, service ports, liquid receivers and accumulators.
 - c. Both liquid and suction lines must be individually insulated between the outdoor and indoor units on heat pump units. Liquid line insulation is not required on cooling only units.
 - d. The outdoor unit can be wired and piped with outdoor unit access from left, right, rear or bottom.
 - e. The sound pressure at rated conditions: maximum of 58 decibels dB(A) at 3 feet from the front of the unit. Provide with night operation mode capable of operating at further reduced noise.
 - f. The system will automatically restart operation after a power failure and will not cause any settings to be lost, thus eliminating the need for re-programming.
 - g. The outdoor unit shall be modular in design and should allow for side-by-side installation with minimum spacing.

- h. The following safety devices shall be included on the condensing unit; high pressure switch, control circuit fuses, crankcase heaters, fusible plug, high pressure switch, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers, and sub-cooling feature. Oil recovery cycle shall be automatic occurring 1 hour after start of operation and then every 6 hours of operation.
 - i. The outdoor unit shall be capable of full heat pump heating operation at 0°F dry bulb ambient temperature without additional low ambient controls. Provide for 100% heat pump heating capacity down to minus 4 deg F, with partial capacity heat pump operation down to no greater than minus 13 deg F.
- 2. Unit Cabinet:
 - a. The outdoor unit shall be completely weather proof and corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.
- 3. Fan:
 - a. The outdoor unit shall consist of one or two propeller type, direct-drive fan motors that have multiple speed operation via a DC inverter.
 - b. The outdoor unit fan motor shall have multiple speed operation of the DC inverter type, controlled to modulate as required to maintain head pressure.
 - c. The fan motor shall have internal thermal overload protection and permanently lubricated bearings and be mounted on rubber in shear isolators.
 - d. Provide a fan guard to prevent contact with moving parts, constructed of welded wire and plated or painted for corrosion resistance.
- 4. Outdoor Coil:
 - a. Manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.
 - b. The coil shall be of a waffle louver fin and high heat exchanger, rifled bore tube design to ensure highly efficient performance.
 - c. The coils shall be complete with corrosion treatment of an acrylic resin type. The thickness of the coating must be between 2.0 to 3.0 microns.
- 5. Compressor:
 - a. The scroll compressor shall be variable speed (PWM inverter) controlled, changing speed to follow the variations in total cooling load as determined by the suction gas pressure as measured in the condensing unit.
 - b. The inverter driven compressor in each condensing unit shall be of highly efficient reluctance DC, hermetically sealed scroll type with a maximum speed of 6,480 rpm.
 - c. Neodymium magnets shall be adopted in the rotor construction to yield a higher torque and efficiency in the compressor instead of the normal ferrite magnet type. At complete stop of the compressor, the neodymium magnets will position the rotor into the optimum position for a low torque start.

- d. The capacity control range shall be modulating from 14% to 100%.
 - e. Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.
 - f. Oil separators shall be standard with the equipment together with an oil balancing circuit.
 - g. The compressor shall be mounted to avoid the transmission of vibration.
6. Electrical:
- a. The power supply to the outdoor unit shall be in voltage and phasing as shown on the drawings, with a tolerance of +/- 10% from nominal indicated.
 - b. The control voltage between the indoor and outdoor unit shall be low voltage control wiring compatible with the energy management and control system as specified in Section 23 09 00. The control wiring shall be a multiplex communication system, making it possible to connect multiple indoor units to one outdoor unit with one cable, thus simplifying the wiring operation.

D. Indoor Unit – Wall Mount Unit

- 1. General: The indoor unit shall be a wall mounted fan coil unit, operable with refrigerant R-32, for installation onto a wall within a conditioned space, with a white casing. Computerized control shall be used to maintain room temperature within 1°F. A mildew-proof, polystyrene air filter and condensate drain pan shall be included as standard equipment. The indoor units sound pressure shall range from 32 dB(A) to 35 dB(A) at low speed measured at 3.3 feet below and from the unit.
- 2. Indoor Unit:
 - a. The indoor unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch. The unit shall have an auto-swing louver which ensures efficient air distribution, which closes automatically when the unit stops. The remote controller shall be able to set five (5) steps of discharge angle. The front grille shall be easily removed for washing. The discharge angle shall automatically set at the same angle as the previous operation upon restart. The drain pipe can be fitted to from either left or right sides.
 - b. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
 - c. Both refrigerant lines shall be insulated from the outdoor unit.
 - d. Return air shall be through a resin net mold resistant filter.

- e. The indoor units shall be equipped with an insulated corrosion proof condensate pan under the coil capturing and controlling all condensate.
 - f. Provide a condensate pump with a 21 inch lift located below the coil in the condensate pan, complete with a built in discharge check valve and safety high level alarm with interlock.
 - g. The indoor units shall be equipped with a return air thermistor.
 - h. The indoor unit will be separately powered with 208~230V/1-phase/60Hz.
 - i. The voltage range will be 253 volts maximum and 187 volts minimum.
3. Unit Cabinet:
- a. The cabinet shall be affixed to a factory supplied wall mounting template and located in the conditioned space.
 - b. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.
4. Fan:
- a. The fan shall be a direct-drive cross-flow fan, statically and dynamically balanced impeller with high and low fan speeds available.
 - b. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output range 0.054 to 0.058 HP.
 - c. The air flow rate shall be available in high and low settings.
 - d. The fan motor shall be thermally protected.
5. Coil:
- a. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
 - b. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
 - c. The coil shall be a 2 row cross fin copper evaporator coil completely factory tested.
 - d. The refrigerant connections shall be flare connections and the condensate will be 1-1/4 inch outside diameter PVC.
 - e. A thermistor will be located on the liquid and gas line.
 - f. A condensate pan shall be located in the unit.
6. Electrical:
- a. A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.
 - b. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
 - c. Transmission (control) wiring between the indoor and remote controller shall be a maximum distance of 1,640 feet.

7. Control:

- a. The unit shall have controls to perform input functions necessary to operate the system.
- b. The unit shall be compatible with interfacing with connection to LonWorks or BACnet networks and as required interfacing with EMCS.

2.2 CONCEALED CEILING DUCTED UNIT - MEDIUM STATIC (ABOVE 0.45 IN WG)

- A. General: The concealed fan coil unit, operable with refrigerant R-410A, equipped with an electronic expansion valve, for installation into the ceiling cavity. It is constructed of a galvanized steel casing. It shall be a horizontal discharge air with horizontal return air configuration. All models feature a low height (15-3/8") cabinet making them applicable to ceiling pockets that tend to be shallow. Computerized PID control shall be used to maintain room temperature within 1°F. The unit shall be equipped with a programmed drying mechanism that dehumidifies while inhibiting changes in room temperature when used with factory remote control sensor. The indoor units sound pressure shall range from 41 dB(A) to 45 dB(A) at low speed measured 5 feet below the ducted unit.
- B. Performance: Each unit's performance is based on nominal operating conditions:
- C. Indoor Unit:
 1. The unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch. The unit shall have an adjustable external static pressure switch.
 2. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
 3. Both refrigerant lines shall be insulated from the outdoor unit.
 4. The indoor units shall be equipped with a return air thermistor.
 5. The indoor unit will be separately powered with 208~230V/1-phase/60Hz.
 6. The voltage range will be 253 volts maximum and 187 volts minimum.
 7. Unit Cabinet:
 - a. The cabinet shall be located into the ceiling and ducted to the supply and return openings.
 - b. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.
 - c. Optional high efficiency air filters are available for each model unit.

8. Fan:
 - a. The fan shall be direct-drive fan, statically and dynamically balanced impeller with high and low fan speeds available.
 - b. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output range 0.21, 0.36 and 0.58 HP respectively.
 - c. The airflow rate shall be available in high and low settings.
 - d. The fan motor shall be thermally protected.
 - e. Fan motor external static pressure.
9. Coil:
 - a. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
 - b. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
 - c. The coil shall be a 3 row cross fin copper evaporator coil with 13 fpi design completely factory tested.
 - d. The refrigerant connections shall be flare connections and the condensate will be 1-1/4 inch outside diameter PVC.
 - e. A thermistor will be located on the liquid and gas line.
10. Electrical:
 - a. A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.
 - b. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
 - c. Transmission (control) wiring between the indoor and remote controller shall be a maximum distance of 1,640 feet.
11. Control:
 - a. The unit shall have controls provided by Manufacturer to perform input functions necessary to operate the system.
 - b. The unit shall be compatible with interfacing with connection to LonWorks networks or interfacing with connection to BMS system.
12. Accessories Available:
 - a. Provide wall mounted, hard wired remote sensor kit is recommended for ceiling-embedded type fan coils, which often result in a difference between set temperature and actual temperature. The sensor for detecting the temperature can be placed away from the indoor unit (branch wiring is included in the kit).
 - b. A high efficiency air filter, 90% efficiency.
 - c. Condensate pump.

D. Controls:

1. Provide intelligent touch controller to control entire system. Provide gateway to seamlessly interface with EMCS.
2. Provide Simplified wired remote controller for each space. All room controllers to wire to intelligent touch controller which can be monitored at the OWS.

E. Manufacturers:

1. Basis of design is as scheduled on the drawings.
2. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Basis of Design: Daikin.
 - b. Sanyo.
 - c. Trane / Mitsubishi.
 - d. Or approved equal

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Examine conditions under which unitary air conditioning equipment is to be installed and notify affected Contractors and Architect in writing of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in an acceptable manner.
1. When conditions are confirmed to be acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to Architect written confirmation. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable.

3.2 INSTALLATION

- A. Install in strict accordance with manufacturer's recommendations and as follows.
1. Provide combination equipment / piping curb in proper position on roof, secured and leveled as recommended by manufacturer. Provide sufficient portals in pipe penetration portion of curb for refrigerant, electrical power, and control wiring.
- B. Provide all required supports, attachment devices, vibration isolators, gasketing, sealants, and accessories needed to insure stable, quiet, leak free operation.
- C. Provide all refrigerant piping in strict accordance with section 23 23 00 – Refrigerant Piping.

- D. Run insulated condensate drain line to approved point of indirect waste disposal through properly sized P-trap. Pitch drain line continuously in direction of flow. If gravity drain is not possible, provide condensate removal pump as specified, piped to nearest approved point of indirect waste disposal.

3.3 FACTORY START UP AND FIELD QUALITY CONTROL

- A. Provide authorized factory representative to start-up unit, check following items, and furnish report:
 - 1. Measure and check voltage of components.
 - 2. Check removal of shipping bracing.
 - 3. Proper connection of drains.
 - 4. Check control circuitry, operation, and performance during all modes of operation.
 - 5. Fan check (RPM, motor amps, rotation, belt tension, etc.).
 - 6. All wiring circuits.
 - 7. All accessory equipment operation, such as filters, controls, condensate drain, etc.

END OF SECTION 23 62 13

SECTION 23 72 00 - AIR-TO-AIR ENERGY RECOVERY EQUIPMENT**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Packaged energy recovery units. (DOAS UNITS and RTUs)

1.3 SUBMITTALS, GENERAL

- A. General: Submit all action submittals and informational submittals required by this Section concurrently.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: For air-to-air energy recovery equipment. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, elevations, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved.

1.6 CLOSEOUT SUBMITTALS

- A. Field quality-control reports.

- B. Operation and Maintenance Data: For air-to-air energy recovery equipment to include in maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. AHRI Compliance:
 - 1. Capacity ratings for air-to-air energy recovery equipment shall comply with AHRI 1060, "Performance Rating of Air-to-Air Heat Exchangers for Energy Recovery Ventilation Equipment."
 - 2. Capacity ratings for air coils shall comply with AHRI 410, "Forced-Circulation Air-Cooling and Air-Heating Coils."
- C. ASHRAE Compliance:
 - 1. Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
 - 2. Capacity ratings for air-to-air energy recovery equipment shall comply with ASHRAE 84, "Method of Testing Air-to-Air Heat Exchangers."
- D. NRCA Compliance: Roof curbs for roof-mounted equipment shall be constructed according to recommendations of NRCA.
- E. UL Compliance:
 - 1. Packaged heat recovery ventilators shall comply with requirements in UL 1812, "Ducted Heat Recovery Ventilators"; or UL 1815, "Nonducted Heat Recovery Ventilators."
 - 2. ETL listed and wired according to the NEC with UL listed power components.
- F. Unit shall comply with NFPA 90A requirements for flame spread and smoke generation, including the unit insulation.
- G. Air flow data shall be in accordance with AMCA 210 testing method.

1.8 COORDINATION

- A. Coordinate layout and installation of air-to-air energy recovery equipment and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.
- B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of air-to-air energy recovery equipment that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Packaged Energy Recovery Units: One year.
 - 2. Warranty Period for Fixed-Plate Total Heat Exchangers: 10 years.

1.10 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filters: One set of each type of filter specified.
 - 2. Fan Belts: One set of belts for each belt-driven fan in energy recovery units.

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Acceptance at Site
 - 1. Inspect the factory packaging before opening and note any damage on the packing slip. Unpack and inspect the unit before acceptance. Dents or scratches of the casing of the unit, or substantial damage to the packing materials that may indicate internal damage to the unit, shall be cause for rejection of the unit.
- B. Storage and Protection
 - 1. After acceptance on site, until such time as the unit is being actively installed, package the unit in protective materials and stored in a protected location so as to protect the function and appearance of the unit in the as accepted condition.

PART 2 - PRODUCTS

2.1 PACKAGED ENERGY RECOVERY UNITS (DOAS UNITS or ROOFTOP UNITS)

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Basis of design: Daikin
 - 2. Or approved equal
- B. Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- C. Housing: Manufacturer's standard construction with corrosion-protection coating and exterior finish, gasketed and calked weathertight, hinged access doors, removable panels with neoprene gaskets for inspection and access to internal parts, minimum 2 inch thick thermal insulation, knockouts for electrical and piping connections, exterior drain connection, and lifting lugs.

1. Inlet: Weatherproof hood or louver, with damper for exhaust and supply.
 - a. Exhaust: Spring-return, two-position, motor-operated damper.
 - b. Supply: Spring-return, two-position, motor-operated damper.
- D. Heat Recovery Device:
 1. Cross Flow Fixed Plate Exchangers:
 - a. Construction: Heat exchanger to be of cross or counter flow airflow configuration with a continuously folded sheet of minimum of 2 square feet of plate heat transfer surface per cfm. Material to be type 1100 alloy aluminum or type 304 stainless steel, minimum plate thickness 0.008 inch. Heat exchanger framework and plates shall be constructed of the same material, separated from dissimilar metal casing by dielectric gasketing if aluminum, and fastened to the unit casing by approved stainless steel fasteners. Plates shall be mechanically crimped together, with coated and encapsulated seams to eliminate cross leakage, and must operate at 10 inches w.g. differential pressure without visible plate deflection.
 2. Rotary Wheel Heat Exchangers:
 - a. Enthalpy recovery wheel systems shall incorporate a removable cassette to facilitate maintenance.
 - b. Rotors shall be mounted on a structural framework using replaceable pillow block or flanged ball bearings.
 - c. Seals shall be of a design that eliminates wheel surface scoring and limits cross contamination between supply and exhaust airstreams to less than 1 percent. A purge section may be utilized to limit cross contamination, but with no relaxation of the minimum effectiveness requirements.
 - d. Wheel media shall be of either aluminum with a surface bonded desiccant or fibrous synthetic with an impregnated desiccant and shall be rated by the manufacturer for repeated washing with either low pressure steam or hot water with negligible loss of latent effectiveness. Aluminum wheels with a surface oxide desiccant coating shall not be permitted. Desiccant shall incorporate a molecular sieve prohibiting passage of gas molecules equal to or larger than 4 Angstrom.
- E. Supply and Exhaust Fans: Forward-curved, centrifugal fan with spring isolators and insulated flexible duct connections.
 1. Motor and Drive: Drive type indicated on Drawings.
 2. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Electrical Requirements for HVAC Equipment."
 3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
 5. Spring isolators on each fan having 1 inch static deflection.
- F. Extended-Surface, Disposable Panel Filters:
1. Comply with NFPA 90A.
 2. Filter Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lift out from access plenum.
 3. Factory-fabricated, dry, extended-surface type.
 4. Thickness: 2 inches.
 5. Minimum Arrestance: 90, according to ASHRAE 52.1.
 6. Minimum Merv: 8, according to ASHRAE 52.2.
 7. Media: Fibrous material formed into deep-V-shaped pleats and held by self-supporting wire grid.
 8. Media-Grid Frame: Galvanized steel.
 9. Mounting Frames: Welded, galvanized steel with gaskets and fasteners, suitable for bolting together into built-up filter banks.
- G. Cooling Coils: Rated according to AHRI 410 and ASHRAE 33, and bearing the AHRI label.
1. Access: Fabricate coil section to allow removal and replacement of coil and to allow in-place access for service and maintenance of coil(s).
 2. Casing: Aluminum
 3. Tubes: Copper.
 4. Tube Headers: Copper.
 5. Fins: Aluminum.
 6. Fin and Tube Joint: Mechanical bond.
 7. Leak Test: Coils shall be leak tested with air under water.
 8. Refrigerant Coils:
 - a. Capacity Reduction: Circuit coils for face control.
 - b. Suction and Distributor: Seamless copper tube with brazed joints.

H. Self-Contained Refrigerant Circuit

1. Outdoor coils shall be cast aluminum, micro-channel coils. Plate fins shall be protected and brazed between adjoining flat tubes such that they shall not extend outside the tubes. A sub-cooling coil shall be an integral part of the main outdoor air coil. Each outdoor air coil shall be factory leak tested with high-pressure air under water.
2. Fan motors shall be an ECM type motor for proportional control. The unit controller shall proportionally control the speed of the condenser fan motors to maintain the head pressure of the refrigerant circuit in ambient conditions up to 125°F]. Mechanical cooling shall be provided to 0°F. Heat Pump Heating shall be provided to -10°F. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase.
3. The condenser fan shall be low noise blade design. Fan blade design shall be a dynamic profile for low tip speed. Fan blade shall be of a composite material.
4. The unit shall have scroll compressors. One of the compressors shall be an inverter compressor providing proportional control. The unit controller shall control the speed of the compressor to maintain the discharge air temperature. [The inverter compressor shall have a separate oil pump and an oil separator for each compressor that routes oil back to the compressor instead of through the discharge line.
5. Pressure transducers shall be provided for the suction pressure and head pressure. Temperature sensor shall be provided for the suction temperature and the refrigerant discharge temperature of the compressors. All of the above devices shall be an input to the unit controller and the values be displayed at the unit controller.
6. Refrigerant circuit shall have a bypass valve between the suction and discharge refrigerant lines for low head pressure compressor starting and increased compressor reliability. When there is a call for mechanical cooling the bypass valve shall open to equalizing the suction and discharge pressures. When pressures are equalized the bypass valve shall close and the compressor shall be allowed to start.
7. Each circuit shall be dehydrated and factory charged with R32 Refrigerant and oil.

I. Cooling-Coil Condensate Drain Pans:

1. Fabricated from stainless-steel sheet and sloped in multiple planes to collect and drain condensate from cooling coils, coil piping connections, coil headers, and return bends.
2. Complying with requirements in ASHRAE 62.1.
3. Drain Connections: At low point of pan with minimum size indicated, threaded nipple.
4. Units with stacked coils shall have an intermediate drain pan to collect and drain condensate from top coil.

- J. Piping and Wiring: Fabricate units with space within housing for piping and electrical conduits. Wire motors and controls so only external connections are required during installation.
1. Indoor Enclosure: NEMA 250, Type 12 enclosure contains relays, starters, and terminal strip.
 2. Outdoor Enclosure: NEMA 250, Type 3R enclosure contains relays, starters, and terminal strip.
 3. Include fused disconnect switches.
 4. Variable-speed controller to vary fan capacity from 100 to approximately 50 percent.
- K. Accessories:
1. Roof Curb: Aluminum with gasketing, and factory-installed wood nailer; complying with NRCA standards; minimum height of 12 inches or as otherwise indicated.
 2. Exhaust weather hood with birdscreen.
 3. Low-Leakage, Isolation Dampers: Double-skin, airfoil-blade, extruded-aluminum dampers with compressible jamb seals and extruded-vinyl blade edge seals, in opposed blade arrangement with cadmium-plated steel operating rods rotating in stainless-steel sleeve bearings mounted in a single extruded-aluminum frame, with operating rods connected with a common linkage, and electric damper operator factory wired. Leakage rate shall not exceed 5 cfm/sq. ft. at 1-inch wg and 9 cfm/sq. ft. at 4-inch wg .
 4. Duct flanges.
 5. Hinged access doors with quarter-turn latches.
 6. Drain pans for condensate removal complying with ASHRAE 62.1.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine casing insulation materials and filter media before air-to-air energy recovery equipment installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for electrical services to verify actual locations of connections before installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.
- E. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 INSTALLATION

- A. Roof Curb: Install air-to-air energy recovery equipment on curbs and coordinate roof penetrations and flashing with roof construction specified in Division 07 Section "Roof Specialties." Secure air-to-air energy recovery equipment to upper curb rail, and secure curb base to roof framing with anchor bolts.
- B. Unit Support: Install unit level on structural curbs.
- C. Install units with clearances for service and maintenance.
- D. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.
- E. Pipe drains from units and drain pans to nearest roof drain; use same size as condensate drain connection.

3.3 CONNECTIONS

- A. Install piping adjacent to unit to allow service and maintenance.
- B. Connect piping to units mounted on vibration isolators with flexible connectors.
- C. Connect cooling condensate drain pans with air seal trap at connection to drain pan and install cleanouts at changes in pipe direction.
- D. Refrigerant Piping: Comply with applicable requirements in Division 23 Section "Refrigerant Piping."
- E. Comply with requirements for ductwork specified in Division 23 Section "Ductwork."
- F. Electrical Connections: Comply with applicable requirements in Division 26 Sections.
 - 1. Install electrical devices furnished with units but not factory mounted.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

2. Adjust seals and purge.
 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 4. Set initial temperature and humidity set points.
 5. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- D. Air-to-air energy recovery equipment will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-to-air energy recovery units.

END OF SECTION 23 72 00

SECTION 23 81 29 - VARIABLE REFRIGERANT FLOW SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes: Include labor, materials, equipment, skills, and related services necessary to furnish and install the variable refrigerant flow system as shown on Drawings and specified.
- B. Related Requirements:
 - 1. Section 23 05 00: Common Work Results For HVAC.
 - 2. Section 23 05 13: Common Electrical Requirements for HVAC Equipment.
 - 3. Section 23 05 29: Hangers and Supports for HVAC Components.
 - 4. Section 23 05 43: Mechanical Vibration and Movement Control.
 - 5. Section 23 05 93: Testing, Adjusting, and Balancing for HVAC.
 - 6. Section 23 09 00: Instrumentation and Control for HVAC
 - 7. Section 23 23 00: Refrigerant Piping.
 - 8. Section 23 31 00: Ductwork.
 - 9. Section 23 33 00: Ductwork Accessories.

1.3 REFERENCES

- A. Air Conditioning Heating and Refrigeration Institute (AHRI)
- B. Air Movement and Control Agency (AMCA)
- C. American Society of Heating, Refrigerating and Air Conditioning Engineers Inc. (ASHRAE)
- D. National Fire Protection Association (NFPA):
- E. NFPA 70, National Electric Code
- F. Underwriters' Laboratories (UL)

1.4 SYSTEM DESCRIPTION

- A. General Requirements:
- B. Variable capacity, heat pump air conditioning system shall be a variable refrigerant flow series (heat/cool model) split system. The system shall consist of multiple evaporators using PID control and outdoor unit. The outdoor unit shall be a direct expansion (DX), air cooled heat pump air conditioning system, variable speed driven compressor multi zone split system, using R-32 refrigerant. The outdoor unit may connect an indoor evaporator capacity up to 130 percent to that of the outdoor condensing unit capacity. All indoor units are each capable of operating separately with individual temperature control.

- C. Outdoor unit shall be interconnected to indoor units which shall range in capacity from 5,000 BTU per hour to 48,000 BTU per hour in accordance with the manufacturer's engineering data book detailing each available indoor unit. The indoor units shall be connected to the outdoor utilizing the manufacturer's specified piping joints and headers.
- D. Contractor shall consult with the manufacturer during the Bidding and Construction phases to insure that a total system shall be provided to include items not shown or specified. The manufacture shall provide a detailed layout with all components and sizes for a complete system.
- E. Contractor and installation team shall be factory trained for the installation of this system.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Submittal shall include a schedule of units to be used, listed in order of room numbers.
 - 2. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for.
 - 3. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Welding certificates.
- C. Field quality-control reports: Completed verification and commissioning submitted to and approved by the manufacturer.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For maintenance manuals.
- B. Software and Firmware Operational Documentation:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On magnetic media or compact disk, complete with data files.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.

1.8 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
 - 1. Product Acceptance: Units shall be of the high efficiency type and shall be made by a manufacturer regularly engaged in production of such units and issuing a complete catalog data on such products.

2. Efficiency: Heat pumps shall be generated to produce an Energy Efficiency Ratio (EER) and a weighted average Coefficient of Performance (COP) in accordance with AHRI Standards 325 and 330.
 3. The units shall be listed by Intertek Testing Services (ITS) (formerly ETL) and bear the ITS label or (UL) listing.
 4. The system shall bear the Energy Star label.
 5. The system shall be produced in an ISO 9001 and ISO 14001 facility, which are standards set by the International Standard Organization (ISO). The system shall be factory tested for safety and function.
 6. The outdoor unit shall be factory charged with R-32.
 7. All units must meet or exceed the federal minimum efficiency requirements and ASHRAE 90.1 efficiency requirements for VRF systems. Efficiency shall be published in accordance with the DOE alternative test procedure, which is based on the Air Conditioning, Heating, and Refrigeration Institute (AHRI) Standards 340/360, 1230 and ISO Standard 13256 1.
- B. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
1. System piping layout shall be designed by a factory designer.
- C. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- D. Regulatory Requirements:
1. New York State Building Code
 2. National Electric Code

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Storage and Handling: Unit shall be stored and handled in accordance with the manufacturer's recommendations.

1.10 WARRANTY

- A. Manufacturer's Special Warranty: Manufacturer and Installer agree to repair or replace components of that fail(s) in materials or workmanship within specified warranty period.
1. Warranty Period: Extended manufacturer's limited warranty for a period of 7 years from date of Substantial Completion.
 2. In addition, provide coverage of the compressor for an extended time period from the end of the 1 year coverage through the 7th year.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Basis of Design: Daikin US Corporation.
 - 2. Trane/ Mitsubishi
 - 3. Sanyo.
 - 4. Or Approved equal
- B. System Requirements: Complete system of outdoor units, indoor units, and controls shall be of one manufacturer.

2.2 OUTDOOR UNIT

- A. General Requirements: Outdoor unit is designed specifically for use with VRF Series components.
 - 1. Outdoor unit shall be factory assembled and pre wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of a scroll compressor, motors, fans, condenser coil, electronic expansion valve, solenoid valves, 4 way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports, liquid receivers, and accumulators.
 - 2. Both liquid and suction lines must be individually insulated between the outdoor and indoor units.
 - 3. Outdoor unit can be wired and piped with outdoor unit access from left, right, rear or bottom.
 - 4. Connection ratio of indoor units to outdoor unit shall be 50 percent to 130 percent.
 - 5. Sound pressure dB(A) at rated conditions shall be a value of 58 decibels at 3 feet from the front of the unit. The outdoor unit shall be capable of operating at further reduced noise during night time.
 - 6. System will automatically restart operation after a power failure and will not cause any settings to be lost, thus eliminating the need for re programming.
 - 7. Outdoor unit shall be modular in design and should allow for side by side installation with minimum spacing.

8. The following safety devices shall be included on the condensing unit; high pressure switch, control circuit fuses, crankcase heaters, fusible plug, high pressure switch, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter, and anti-recycling timers. To ensure the liquid refrigerant does not flash when supplying to the various fan coil units, the circuit shall be provided with a sub cooling feature. Oil recovery cycle shall be automatic occurring 1 hour after start of operation and then every 6 hours of operation.
9. Outdoor unit shall be capable of heating operation at -13 degrees F dry bulb ambient temperature without additional low ambient controls.
10. A factory outdoor twinning kit or factory approved device shall be used to connect (2) or more outdoor units together.
11. Provide hail guards.

B. Unit Cabinet:

1. Outdoor unit shall be completely weather proof and corrosion resistant. The unit shall be constructed from rust proofed mild steel panels coated with a baked enamel finish.

C. Fan:

1. Condensing unit shall consist of one propeller type, direct drive fan, 750 watt motors that have multiple speed operation via a DC inverter.
2. Condensing unit fan motor shall have multiple speed operation of the DC inverter type, and be of high external static pressure and shall be factory set as standard at 0.12 inch w.g. with available by field setting switch to a maximum 0.24 inch w.g. pressure.
3. Fan shall be a vertical discharge configuration.
4. Fan motor shall have inherent protection and permanently lubricated bearings and be mounted.
5. Fan motor shall be provided with a fan guard to prevent contact with moving parts.

D. Condenser Coil:

1. Condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.
2. Coil shall be of a waffle louver fin and high heat exchanger, rifled bore tube design to ensure highly efficient performance.
3. Coils shall be complete with corrosion resistant treatment of an acrylic resin type. The thickness of the coating must be between 2.0 to 3.0 microns.
4. Coils shall be protected with an integral metal guard.

E. Compressor:

1. Scroll compressor shall be variable speed controlled which is capable of changing the speed to follow the variations in total cooling load as determined by the suction gas pressure as measured in the condensing unit.
2. Inverter driven compressor in each condensing unit shall be of highly efficient reluctance DC, hermetically sealed scroll type with a maximum speed of 6,480 rpm.
3. Capacity control range shall be 14 percent to 100 percent, with (29) individual capacity steps. Each non inverter compressor shall also be of the hermetically sealed scroll type.
4. Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.
5. Compressor shall be mounted to avoid the transmission of vibration.

F. Electrical:

1. Power supply to the outdoor unit shall be 208/230 volts, 3 phase, 60 Hertz.
2. Control voltage between the indoor and outdoor unit shall be 24 VDC shielded 2 conductor cable.
3. Control wiring shall be a 2 wire multiplex transmission system, making it possible to connect multiple indoor units to (1) outdoor unit with (1) 2 cable wire, thus simplifying the wiring operation.

2.3 4 WAY CEILING CASSETTE UNIT (3' x 3')

A. General: Indoor ceiling cassette fan coil unit, operable with R-32 refrigerant, equipped with an electronic expansion valve, for installation into the ceiling cavity equipped with an air panel grill. It shall be a four-way air distribution type, ivory white, impact resistant, and washable decoration panel. The supply air is distributed via motorized louvers which can be horizontally and vertically adjusted from 0° to 90°. Computerized PID control shall be used to maintain room temperature within 1°F. Equipped with a programmed drying mechanism that dehumidifies while inhibiting changes in room temperature when used with factory remote control sensor. The indoor units sound pressure shall range from 28 dB(A) to 33 dB(A) at low speed measured at 5 feet below the unit.

B. Performance: Each unit's performance is based on nominal operating conditions:

C. Indoor Unit:

1. The unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.
2. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.

3. Both refrigerant lines shall be insulated from the outdoor unit.
4. The 4-way supply air flow can be field modified to 3-way and 2-way airflow to accommodate various installation configurations including corner installations.
5. Return air shall be through the concentric panel, which includes a resin net mold resistant filter.
6. The indoor units shall be equipped with a condensate pan and condensate pump with safety overflow switch. The condensate pump provides up to 21" of lift.
7. The indoor units shall be equipped with a return air thermistor.
8. The indoor unit will be separately powered with 208~230V/1-phase/60Hz.
9. The voltage range will be 253 volts maximum and 187 volts minimum.

D. Unit Cabinet:

1. The cabinet shall be space saving and shall be located into the ceiling.
2. Three auto-swing positions shall be available to choose, which include standard, draft prevention and ceiling stain prevention.
3. The airflow of the unit shall have the ability to shut down one or two sides allowing for simpler corner installation.
4. A branch duct knockout shall exist for branch ducting supply air.
5. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

E. Fan:

1. The fan shall be direct-drive turbo fan type with statically and dynamically balanced impeller with high and low fan speeds available.
2. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output range from 0.06 to 0.12 HP.
3. The airflow rate shall be available in high and low settings.
4. The fan motor shall be thermally protected.

F. Filter:

1. The return air shall be filtered by means of a washable long-life filter with mildew proof resin.

G. Coil:

1. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
3. The coil shall be a 2-row cross fin copper evaporator coil with 17 FPI design completely factory tested.

4. The refrigerant connections shall be flare connections and the condensate will be 1 -1/4 inch outside diameter PVC.
5. A thermistor will be located on the liquid and gas line.

H. Electrical:

1. A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.
2. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
3. Transmission (control) wiring between the indoor and remote controller shall be a maximum distance of 1,640 feet.

I. Control:

1. The unit shall have controls provided by Manufacturer to perform input functions necessary to operate the system.
2. The unit shall be compatible with interfacing with connection to LonWorks networks or interfacing with connection to BMS system.

2.4 4 WAY CEILING CASSETTE UNIT (2' x 2')

- A. General: The indoor unit ceiling cassette fan coil unit, operable with R-32 refrigerant, equipped with an electronic expansion valve, for installation into the ceiling cavity equipped with an air panel grill. It shall be a four-way air distribution type, ivory white, impact resistant, and washable decoration panel. The supply air is distributed via motorized louvers which can be horizontally and vertically adjusted from 0° to 90°. Computerized PID control shall be used to maintain room temperature within 1°F. Equipped with a programmed drying mechanism that dehumidifies while inhibiting changes in room temperature when used with factory remote control sensor. The indoor units sound pressure shall range from 25 dB(A) to 33 dB(A) at low speed measured at 5 feet below the unit.
- B. Performance: Each unit's performance is based on nominal operating conditions:
- C. Indoor Unit:
1. The indoor unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.
 2. The indoor units shall be equipped with a condensate pan and condensate pump with safety overflow switch. The condensate pump provides up to 21" of lift.
 3. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.

4. Both refrigerant lines shall be insulated from the outdoor unit.
5. The 4-way supply air flow can be field modified to 3-way and 2-way airflow to accommodate various installation configurations including corner installations.

D. Unit Cabinet:

1. The cabinet shall be space saving and shall be located into the ceiling.
2. Three auto-swing positions shall be available to choose, which include standard, draft prevention and ceiling stain prevention.
3. The airflow of the unit shall have the ability to shut down one or two sides allowing for simpler corner installation.
4. A branch duct knockout shall exist for branch ducting supply air.
5. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

E. Fan:

1. The fan shall be direct-drive turbo fan type with statically and dynamically balanced impeller with high and low fan speeds available.
2. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output range from 0.06 to 0.12 HP.
3. The airflow rate shall be available in high and low settings.
4. The fan motor shall be thermally protected.

F. Filter:

1. The return air shall be filtered by means of a washable long-life filter with mildew proof resin.

G. Coil:

1. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
3. The coil shall be a 2-row cross fin copper evaporator coil with 17 FPI design completely factory tested.
4. The refrigerant connections shall be flare connections and the condensate will be 1 -1/4 inch outside diameter PVC.
5. A thermistor will be located on the liquid and gas line.

H. Electrical:

1. A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.
2. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
3. Transmission (control) wiring between the indoor and remote controller shall be a maximum distance of 1,640 feet.

I. Control:

1. The unit shall have controls provided by Manufacturer to perform input functions necessary to operate the system.
2. The unit shall be compatible with interfacing with connection to LonWorks networks or interfacing with connection to BMS system.

2.5 CONCEALED CEILING DUCTED UNIT - MEDIUM STATIC (ABOVE 0.45 IN WG)

A. General: The concealed fan coil unit, operable with refrigerant R-410A, equipped with an electronic expansion valve, for installation into the ceiling cavity. It is constructed of a galvanized steel casing. It shall be a horizontal discharge air with horizontal return air configuration. All models feature a low height (15-3/8") cabinet making them applicable to ceiling pockets that tend to be shallow. Computerized PID control shall be used to maintain room temperature within 1°F. The unit shall be equipped with a programmed drying mechanism that dehumidifies while inhibiting changes in room temperature when used with factory remote control sensor. The indoor units sound pressure shall range from 41 dB(A) to 45 dB(A) at low speed measured 5 feet below the ducted unit.

B. Performance: Each unit's performance is based on nominal operating conditions:

C. Indoor Unit:

1. The unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch. The unit shall have an adjustable external static pressure switch.
2. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
3. Both refrigerant lines shall be insulated from the outdoor unit.
4. The indoor units shall be equipped with a return air thermistor.
5. The indoor unit will be separately powered with 208~230V/1-phase/60Hz.
6. The voltage range will be 253 volts maximum and 187 volts minimum.

D. Unit Cabinet:

1. The cabinet shall be located into the ceiling and ducted to the supply and return openings.
2. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.
3. Optional high efficiency air filters are available for each model unit.

E. Fan:

1. The fan shall be direct-drive fan, statically and dynamically balanced impeller with high and low fan speeds available.

2. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output range 0.21, 0.36 and 0.58 HP respectively.
3. The airflow rate shall be available in high and low settings.
4. The fan motor shall be thermally protected.
5. Fan motor external static pressure.

F. Coil:

1. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
3. The coil shall be a 3 row cross fin copper evaporator coil with 13 fpi design completely factory tested.
4. The refrigerant connections shall be flare connections and the condensate will be 1-1/4 inch outside diameter PVC.
5. A thermistor will be located on the liquid and gas line.

G. Electrical:

1. A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.
2. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
3. Transmission (control) wiring between the indoor and remote controller shall be a maximum distance of 1,640 feet.

H. Control:

1. The unit shall have controls provided by Manufacturer to perform input functions necessary to operate the system.
2. The unit shall be compatible with interfacing with connection to LonWorks networks or interfacing with connection to BMS system.

I. Accessories Available:

1. Provide wall mounted, hard wired remote sensor kit is recommended for ceiling-embedded type fan coils, which often result in a difference between set temperature and actual temperature. The sensor for detecting the temperature can be placed away from the indoor unit (branch wiring is included in the kit).
2. A high efficiency air filter, 90% efficiency.
3. Condensate pump.

2.6 BRANCH CONTROLLER /SELECTOR BOX FOR VRF HEAT RECOVERY SYSTEM

- A. General: The branch selector boxes are designed specifically for use with VRF series heat recovery system components.

1. These selector boxes shall be factory assembled, wired, and piped.
2. These branch controllers must be run tested at the factory.
3. These selector boxes must be mounted indoors.
4. When simultaneously heating and cooling, the units in heating mode shall energize their subcooling electronic expansion valve.
5. The number of connectable indoor units shall be in accordance with the table below:

B. Unit Cabinet:

1. These units shall have a galvanized steel plate casing.
2. Each cabinet shall house 5 electronic expansion valves for refrigerant control.
3. The cabinet shall contain a subcooling heat exchanger.
4. The unit shall have sound absorption thermal insulation material made of flame and heat resistant foamed polyethylene.
5. Nominal sound pressure levels shall be as shown below.

C. Refrigerant Valves:

1. The unit shall be furnished with 5 electronic expansion valves to control the direction of refrigerant flow. The use of solenoid valves for changeover and pressure equalization shall not be acceptable due to refrigerant noise.
2. The refrigerant connections must be of the braze type.
3. Each circuit shall have at least one branch selector box. Use of multi-port branch selector boxes shall not be acceptable unless spare ports are provided for redundancy.
4. Multiple indoor units may be connected to a branch selector box with the use of a joint provided they are within the capacity range of the branch selector.

D. Condensate Removal:

1. The unit shall not require provisions for condensate removal.

E. Electrical:

1. The unit electrical power shall be 208/230 volts, 1 phase, 60 hertz.
2. The unit shall be capable of operation within the limits of 187 volts to 255 volts.
3. The minimum circuit amps (MCA) shall be 0.1 and the maximum overcurrent protection amps (MOP) shall be 15.
4. The control voltage between the indoor and condensing unit shall be 16VDC non-shielded 2 conductor cable.

2.7 CONTROL UNIT

A. Physical Characteristics:

1. General: Control system shall be a neutral color plastic material. Each control may have a Liquid Crystal Display (LCD).

B. Electrical Characteristics:

1. General: From each circuit board to the controls, the electrical voltage shall be 16 volts DC.
2. Wiring: Control wiring shall be installed in a daisy chain configuration from indoor unit to indoor unit then to the branch selector box and outdoor unit. Control wiring shall run from the indoor unit terminal block to the specific controller for that unit.
3. Wiring Size: Wire shall be a non-shielded, 2 core sheathed vinyl cord or cable, size AWG18 2.

C. Controller Characteristics:

1. Individual Zone Controller:
 - a. Simplified Wired Remote Controller
 - b. The simplified wired remote controller shall be able to control 1 group (maximum of 16 fan coil units).
2. The simplified wired remote controller shall have the following features:
 - a. Operation - Start/Stop, Operation Mode, Temperature Setting, 60F -90F Set Point Range, Fan Speed, Airflow Direction
 - b. Monitoring - Status, malfunction flashing, malfunction content, filter sign, operation mode, temperature setting, permit/prohibit selection, fan speed, airflow direction.
 - c. Scheduling - ON/OFF Timer.
 - d. Control Management - Field Setting Mode, Group Setting, Auto Restart.
 - e. Similar to Daikin Navigation Remote Controller BRC1E73
3. Centralized Controller:
 - a. Centralized controller shall be capable of controlling a maximum of (128) indoor units across multiple outdoor units. The centralized controller shall be approximately 8 1/2 inch by 10 inch size and shall be powered from a built in power supply. The centralized controller shall support operation superseding that of the remote (room/space) controllers, system configuration, daily/weekly scheduling, monitoring of operation status, and malfunction monitoring. The centralized controller shall have (5) basic operation controls which can be applied to an individual indoor unit, a group of indoor units (up to 128 indoor units), or all indoor units (collective batch operation). This basic control set of operation controls for the centralized controller shall include on/off, operation mode (selection, dry, and fan), temperature setting, fan speed setting, and airflow direction setting. Since the controller provides centralized control, it shall be able to enable or disable operation of local remote (room/space) controllers. In terms of scheduling, the centralized controller shall allow the user to define both daily and weekly schedules with operations consisting of ON/OFF, mode selection, temperature setting, vane direction, fan speed, and permit/prohibit of remote controllers.

4. Centralized controllers shall be equipped with (1) RJ 45 ethernet port to support interconnection with a network PC via a closed/direct Local Area Network (LAN). The centralized controller shall be capable of performing initial settings via a PC using the centralized controller's initial setting browser.
5. Standard software functions shall allow the building manager to securely log into each centralized controller via the PC's web browser to support operation monitoring, scheduling, error email, and online maintenance diagnostics. Standard software functions shall not expire.
6. Provide BACNET connection to tie into district wide building controls.
7. Similar to Daikin: Intelligent Touch Manager (iTM) DCM601B71

2.8 SOURCE QUALITY CONTROL

- A. Tests: Units shall be functionally tested at factory, including safety controls and operation of the voltage tolerance range.

2.9 ARCHITECTURE/COMMUNICATION

- A. General Requirements: The Project shall be comprised of a high speed Ethernet network utilizing BACnet/IP communications between system controllers and workstations. Communications between system controllers and sub networks of custom application controllers and/or application specific controllers shall utilize BACnet/MSTP (RS485) communications.
 1. Each system controller shall perform communications to a network of custom application and application specific controllers using BACnet/MSTP (RS485) as prescribed by the BACnet standard.
- B. Each system controller shall function as a BACnet router to each unit controller providing a unique BACnet device ID for all controllers within the system.

2.10 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."
 1. Enclosure: Totally enclosed, fan cooled.
 2. Efficiency: Premium efficient.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Examine conditions under which VRV/VRF equipment is to be installed and notify affected Contractors and Architect in writing of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in an acceptable manner.
 - 1. When conditions are confirmed to be acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to Architect written confirmation. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable.

3.2 INSTALLATION

- A. Install in strict accordance with manufacturer's recommendations and as follows.
- B. Insulate all refrigerant suction, liquid and hot gas piping. Secure all insulation to piping to eliminate condensation from forming from condensing unit to branch controller box and branch controller box to indoor unit.
- C. Provide all required supports, attachment devices, vibration isolators, gasketing, sealants, and accessories needed to insure stable, quiet, leak free operation.
- D. Run insulated condensate drain line to approved point of indirect waste disposal. Pitch drain line continuously in direction of flow. If gravity drain is not possible, provide condensate removal pump as specified, piped to nearest approved point of indirect waste disposal.
- E. Controls: Individual Room Sensor Controller and Master Controller shall be furnished with units. Contractor shall be responsible for final connections.
- F. Power: Power wiring shall be through disconnect switch to unit as described in Division 26 and called for in Motor Schedule. Other wiring shall be by Contractor responsible for heating work.
- G. Installation Requirements: System shall be installed by a factory trained Contractor of the product installed.
- H. Refrigerant Piping: System shall be capable of refrigerant piping up to 410 equivalent feet, a total combined length of 1,000 feet of piping between the condensing and fan coil units with 165 foot maximum vertical difference, without any oil traps or additional equipment. In case where the outdoor unit is located below the indoor unit, the vertical difference is a maximum of 133 feet.

3.3 FACTORY START UP AND FIELD QUALITY CONTROL

- A. Provide authorized factory representative to start-up unit, check following items, and furnish report:
 - 1. Measure and check voltage of components.

2. Check all refrigerant piping (RL,RS,HG) has been completely insulated.
3. Check removal of shipping bracing.
4. Proper connection of drains.
5. Check control circuitry, operation, and performance during all modes of operation.
6. Fan check (RPM, motor amps, rotation, belt tension, etc.).
7. All wiring circuits.
8. All accessory equipment operation, such as filters, controls, condensate drain, etc.
9. Complete installation and startup checks according to manufacturer's written instructions.

3.4 PROTECTION

- A. Remove and replace products or materials that are wet, moisture damaged, or mold damaged due to condensate leaks.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 23 81 29

SECTION 23 82 00 – TERMINAL HEATING AND COOLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following types of Terminal Heating and Cooling Equipment, associated accessories, and their installation:
 - 1. Packaged Through Wall Air Conditioners (PTAC),
 - 2. Fan-Coil Units (FCU),
 - 3. Fin Tube Radiation (FTR),
 - 4. Unit Heaters (UH),
 - 5. Air Coils (RHC),
 - 6. Low Surface Temperature Panel Radiation,

1.3 SUBMITTALS, GENERAL

- A. General: Submit all action submittals and informational submittals required by this Section concurrently.

1.4 ACTION SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for each unit type and configuration.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Plans, elevations, sections, and details.
 - 2. Details of anchorages and attachments to structure and to supported equipment.
 - 3. Wiring Diagrams: Power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Ceiling suspension components.
 - 2. Method of attaching hangers to building structure.

3. Size and location of initial access modules for acoustical tile.
4. Size and location of access panels in hard ceilings to provide access to concealed units.
5. Items penetrating finished ceiling, including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
6. Perimeter moldings.

1.6 CLOSEOUT SUBMITTALS

- A. Field quality-control test reports.
- B. Operation and Maintenance Data: For unit ventilators blower-coil units, fan-coil units, convectors, fin tube radiation, unit heaters, and air coils to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 1. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.

1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.
- C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.8 COORDINATION

- A. Coordinate layout and installation of all units and suspension system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
- B. Coordinate size and location of wall sleeves for outdoor-air intake and relief dampers.

PART 2 - PRODUCTS

2.1 PACKAGED THROUGH WALL AIR CONDITIONERS (PTAC)

A. General

1. Description: Factory assembled and tested, self-contained, packaged, terminal air conditioner with room cabinet, electric refrigeration system, heating, and temperature controls; fully charged with refrigerant and filled with oil; with cord-connected or hardwired chassis.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Ventilation Rate Procedures," and Section 7 - "Construction and Startup."
4. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.
5. ASHRAE Thermal Comfort: Applicable requirements in ASHRAE 55.
6. UL listed and ETL performance certified.

B. Chassis

1. Cabinet: 0.052-inch-thick powder-coated steel with removable front panel with concealed latches.
 - a. Wall or floor mounting with wall sleeve or subbase as required.
 - b. Angled or Flat Top as scheduled.
 - c. Discharge grille of extruded aluminum allowing four-way discharge air pattern, tamperproof, and carrying a flame test rating in accordance with UL standard 494.
 - d. Louvers: Extruded aluminum with enamel finish; color selected by Architect from no less than 16 manufacturer's standard and premium colors.
 - e. Finish: Baked enamel, color selected by Architect.
 - f. Access Door: Hinged door in top of cabinet for access to controls.
 - g. Cabinet Extension: Where scheduled or shown, matching cabinet in construction and finish, allowing diversion of airflow to adjoining room; with grille.
 - h. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

- i. Hydronic Subbase: Enameled steel with six adjustable leveling feet and adjustable end plates with two-row NPS 5/8 copper tube, aluminum-plate finned coil for use with hot water or steam, normally open low-voltage electric valve for hot water and provision for mounting receptacle, with factory-installed and -wired, fused disconnect switch and receptacle sized for unit.
 - j. Wall Sleeves: Galvanized steel with powder-coated paint.
- 2. Fans:
 - a. Indoor and outdoor fans with separate motors.
 - b. Indoor Fan: Forward curved, centrifugal; with two or three speed motor as scheduled.
 - c. Outdoor fan: Forward curved, centrifugal, or propeller type with one or two speed motor as scheduled.
 - d. Motors comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - 1) Permanently lubricated split capacitor.
 - 2) Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - 3) Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
- 3. Filters: Washable polyurethane in molded plastic frame.
- 4. Condensate Drain: Drain pan to direct condensate to outdoor coil for re-evaporation and piping to direct condensate to building waste and vent piping.
 - a. Comply with ASHRAE 62.1 for drain pan construction and connections.
- C. Refrigeration System: Direct-expansion indoor coil with capillary restrictor and hermetically sealed scroll compressor with vibration isolation and overload protection.
 - 1. Indoor and Outdoor Coils: Seamless copper tubes mechanically expanded into aluminum fins with capillary tube distributor on indoor coil.
 - 2. Accumulator.
 - 3. Constant-pressure expansion valve.
 - 4. Reversing valve.
 - 5. Charge: full, either R-32 or R-410A.
- D. Auxiliary Heating
 - 1. Hot-Water Heating Coil: Seamless copper tubes mechanically expanded into aluminum fins with two-way modulating control valve and air vent

E. Controls

1. Control Module: Unit-mounted digital panel with touchpad temperature control and with touchpad for heating, cooling, and fan operation. Include the following features:
 - a. Heat-Pump Ambient Control: Field-adjustable switch changes to heat-pump heating operation above 40 deg F and to supplemental heating below plus 25 deg F.
 - b. Temperature-Limit Control: Prevents occupant from exceeding preset setback or setup temperature.
 - c. Building Automation System Interface: Allows remote on-off control with setback temperature control.
 - d. Reverse-Cycle Defrost: Solid-state sensor monitors frost buildup on both coils and reverses unit to melt frost.
2. Outdoor Air: Motorized intake damper.

F. Source Quality Control

1. Sound-Power Level Ratings: Factory test to comply with AHRI 300, "Sound Rating and Sound Transmission Loss of Packaged Terminal Equipment."
2. Unit Performance Ratings: Factory test to comply with AHRI 310/380/CSA C744, "Packaged Terminal Air-Conditioners and Heat Pumps."

2.2 FAN COIL UNITS (HEATING ONLY)

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Design Basis: Sterling
 2. Daikin
 3. Trane.
 4. Or approved equal
- B. Description: A factory-assembled and -tested unit complying with AHRI 440.
- C. Coil Section Insulation: Comply with NFPA 90A or NFPA 90B. Unicellular polyethylene thermal plastic, preformed sheet insulation complying with ASTM C 534, Type II, except for density.
1. Thickness: 1 inch.
 2. Thermal Conductivity (k-Value): 0.24 Btu x in./h x sq. ft. at 75 deg F mean temperature.
 3. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM C 411.
 4. Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

- D. Cabinet: Steel with baked-enamel finish with manufacturer's standard paint, in color selected by Architect.
1. Horizontal Unit, Exposed Bottom Panels: Minimum 0.0528-inch-thick, galvanized, sheet steel, removable panels secured with tamperproof cam fasteners and safety chain, fitted with stamped steel bottom inlet and discharge grilles where shown without connecting ductwork.
 2. Recessing Flanges: Steel, finished to match cabinet.
 3. Control Access Door: Key operated.
- E. Filters: Minimum arrestance according to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
1. Pleated: 90 percent arrestance and 7 MERV.
- F. Hot-Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.
- G. Fan and Motor Board: Removable.
1. Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
 2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Division 23 Section "Common Electrical Requirements for HVAC Equipment."
 3. Wiring Terminations: Connect motor to chassis wiring with plug connection.
- H. Control devices and operational sequences are specified in Division 23 Sections "Instrumentation and Control for HVAC".

2.3 HOT-WATER FINNED TUBE RADIATORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Sterling Hydronics, a Mestek company.
 2. Rittling, a div. of Hydro-Air Components.
 3. Slant/Fin.
 4. Or approved equal
- B. Performance Ratings: Rate baseboard radiators according to Hydronics Institute's "I=B=R Testing and Rating Standard for Baseboard Radiation."

- C. Fin Radiation: Complete enclosure of heavy-duty, institutional grade construction, continuous supporting channel and back plate, heating element, hangers and accessories as required; factory-boxed and tagged by room number and securely anchored to building in a manufacturers approved manner. Enclosures to run from wall-to-wall, unless otherwise indicated on Drawings, and provided with all necessary corner pieces, end caps, column enclosures, butt joint trims, wall sleeves, and all access doors required.
1. Fin Tube Element and Enclosure types: (REFER TO SCHEDULES OF DATA)
 - a. Element constructed of seamless drawn copper tubing mechanically expanded into aluminum full collar or full temper embedded fins of size shown and specified.
 - b. Provide tube size 3/4" through 1-1/4" as required by flow rate. Use same fin tube element tube size as pipe size shown leading to fin tube on drawings.
 - c. Provide elements in lengths, sizes, and capacities as shown on drawings.
 2. Element Supports: Swinging, ball bearing, or sliding type designed to allow for expansion. Supports must allow free noiseless movement of pipe and elements.
 3. Enclosures:
 - a. Complete enclosures to run from wall-to-wall unless otherwise shown and noted on plans.
 - b. Materials:
 - 1) General service: ASTM A-653/653M-94 G90 lock forming quality galvanized steel, prepared for painting via mill phosphatizing in accordance with ASTM A2092, unless otherwise noted.
 - c. Material gauges:
 - 1) 16 ga.: General service.
 - d. Provide continuous enclosure back plate and back hanger channel of 20 ga. roll formed material same as cover, configured for positive support of cover and element. Include continuous urethane foam dirt seal between wall and channel.
 - e. Gusset braced cover construction with stamped outlet and inlet of configuration described above. Provide cover support brackets spaced as recommended by manufacturer but on center distances not greater than 4'. Provide brackets within 6" of end of cover and within 6" (on both sides) of each joint between sections or corner joints. All fasteners shall be concealed or tamper resistant. Fasteners shall match enclosure materials.
 - f. Provide matching die formed end caps, inside and outside corner pieces, wall sleeves, internal end plates, column enclosures, butt strips, valve compartments, riser chases, access doors and other accessories as shown on drawings and as required to fabricate neat, complete installation.

- g. Enclosures and all trim accessories shall be phosphatized and painted inside and out with one coat of baked on alkyd enamel primer, then finished with baked enamel in color selected by Architect.
- 4. Valve Access Panel:
 - a. 12" wide minimum, full enclosure height access door with tamper resistant closure. Provide for reasonable service access where any of the following must be within enclosure (typical):
 - 1) Isolation valve.
 - 2) Air vent or drain.
 - 3) Shut off valves, unions, P/T plugs, etc.
 - 4) Temperature control valve.

2.4 LOW SURFACE TEMPERATURE PANEL RADIATORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Design Basis: ThermoTouch by Runtal North America, Inc.
 - 2. Equal by Embassy Industries, Inc.
 - 3. Equal by Panel Radiator, Inc., a div. of Hydro-Air Components.
- B. Panel Radiators consist a welded assembly of active hot water heating tubes with headers at each end, connected via radiation fins to a front set of inactive tubes, with a total depth of no more than 2-3/4". Include an integral heavy gauge (0.09" minimum) all-welded perforated flat top grille which covers the entire radiator from the front inactive tubes to within 1/4" of the wall.
- C. Panel Radiator Data:
 - 1. Working Pressure 56 psig
 - 2. Tube Thickness: 0.048 inch.
 - 3. Tube Height: As scheduled
 - 4. Tube Depth: As scheduled
 - 5. Tube length: As scheduled or tagged on drawings.
 - 6. Number of Tubes High: 1
 - 7. Number of Tubes Deep: 1
 - 8. Fin Spacing: 32 fins per foot
 - 9. Room Air Temperature: 65 deg F.
 - 10. Heat Output: 542 Btu/h.
 - 11. Average Water Temperature (AWT): 170 deg F.
 - 12. Minimum Surface Temperature (ST) reduction: $AWT - ST = 65$ deg F. minimum.
 - 13. Temperature Drop: 20 deg F.
- D. Mounting: Wall brackets on maximum spacing of 36 inches. Provide all mounting brackets by radiator manufacturer, same finish as panels. Provide all necessary support blocking, intermediate supports, fasteners, etc., to match substrates and panels, as required for durable installation including 200 lb. external point load.

- E. Finish: Gloss powder coated baked-enamel finish on all sides minimum 0.002" thick in any of manufacturer's 10 standard colors as selected by Architect.
- F. Hydronic Headers: Square steel tubing, welded end caps, radiation connections, with threaded piping and air vent connections. Minimum thickness of 0.109 inches. Piping connections 3/4" NPT. Air vent connections 1/8" NPT. Provide internal baffling where required for proper water flow.
- G. Hydronic Radiation Tubes: Welded steel construction, consisting of active flattened hot water heating tubes welded to headers at each end.
- H. Radiator Fins: Corrugated steel welded to inactive front tubes and both sides of the active water tubes starting within 1" of the headers, spot-welded three times to each tube.
- I. Accessories: Provide filler sections, corner covers, end covers, relay sections and access plates matching the enclosure finish.
- J. Provide capacities, sizes, and configurations as scheduled. Provide fittings and valves as detailed.

2.5 PROPELLER UNIT HEATERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Basis of Design: Sterling
 - 2. Engineered Air Ltd.
 - 3. Rosemex Products.
 - 4. Ruffneck Heaters; a division of Lexa Corporation.
 - 5. Trane.
- B. Description: An assembly including casing, coil, fan, and motor in horizontal discharge configuration with adjustable discharge louvers.
- C. Cabinet: Removable panels for maintenance access to controls.
- D. Cabinet Finish: Manufacturer's standard baked enamel applied to factory-assembled and -tested propeller unit heater before shipping.
- E. Discharge Louver: Adjustable fin diffuser for horizontal units.
- F. General Coil Requirements: Test and rate hot-water propeller unit heater coils according to ASHRAE 33.
- G. Hot-Water Coil: Copper tube, minimum 0.025-inch wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 325 deg F, with manual air vent. Test for leaks to 350 psig underwater.
- H. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.

- I. Fan Motors: Comply with requirements in Division 23 Section "Common Electrical Requirements for HVAC Equipment."
- J. Motor Type: Permanently lubricated, multispeed.

2.6 HEATING COILS FOR AIR SYSTEMS

A. General:

- 1. Size for face velocity and maximum pressure drops scheduled. If not scheduled, size to provide maximum of 500 fpm face velocity for cooling coils, 650 fpm face velocity for heating coils, or higher only if restricted by maximum coil size that can fit within existing units.
- 2. All coils to be computer optimized as to size and arrangement to meet requirements listed on drawings. Include computer selection sheets in submittal.
- 3. Certified in accordance with AHRI Standard 410.
- 4. Rate coils for the type and percentage of glycol solution called for, where applicable.

B. Hydronic Heating Coils:

- 1. Coils shall have all performance characteristics as scheduled or otherwise required as a minimum, including size, sensible and latent capacity, number of rows, tubing and circuits, headers, connection sizes, and water and air pressure drops.
- 2. Casings: Refer to drawing details for more information.
 - a. Heating coils shall have continuously galvanized steel casing frames.
- 3. Headers:
 - a. Provide copper, steel, or cast iron headers as required to achieve capacity, even discharge air temperatures, and water pressure drop scheduled.
 - 1) Seamless extra heavy wall copper tubing with brazed brass threaded supply and return connections.
 - 2) Gray cast iron hydrostatically tested to 400 PSIG before assembly. Headers 12 inch and larger shall be tapered to assure uniform distribution to all tubes. Provide threaded or flanged connections.
 - 3) Provide system connection sizes same size as connected piping as shown on drawings, unless otherwise scheduled.
 - 4) Provide drain and vent connections in headers.

4. Tubes, unless otherwise scheduled:
 - a. Seamless, 5/8" O.D., 0.024 inch min. wall copper tube primary surface, expanded into the fin collars for a permanent fin tube bond and brazed copper header into the header for a leak tight joint at 250 PSIG air pressure under water.
 - b. Return bends shall be .035" min. wall machine die formed and wrinkle free at the bend I.D.
5. Fins:
 - a. Continuously configured .006" min. plate type fins with full fin collars for accurate spacing and maximum fin - tube contact.
 - b. General heating coil fin material: aluminum.
 - c. Cooling coil, and as otherwise noted on drawings, fin material: Heresite coated aluminum or copper.
6. The complete coil core shall be tested with 315 psi min. air (or nitrogen) pressure under warm water and guaranteed for 250 psig working pressure.
7. Bronze spring type turbulators shall be used where necessary to attain required capacity at the available GPM and entering water temperature, without increase in scheduled water pressure drop.
8. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Basis of Design: Daikin matched with DOAS or RTU.
 - b. Enviro-tec or equal
 - c. Heatcraft Refrigeration Products LLC; Heat Transfer Division.
 - d. Super Radiator Coils.
 - e. Trane or equal
 - f. USA Coil & Air.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive equipment for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for piping and electrical connections to verify actual locations before unit installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.
- D. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 INSTALLATION

- A. Install equipment in compliance with NFPA 90A.
- B. Install equipment level and plumb.
- C. Suspend motorized equipment from structure with threaded steel rods and minimum 1.0-inch static-deflection spring hangers. Vibration isolators are specified in Section 23 05 43 Mechanical Vibration and Movement Control.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
 - 1. Install piping adjacent to machine to allow service and maintenance.
 - 2. Unless otherwise indicated, install shutoff valve and union or flange at each connection.
 - 3. Connect piping to equipment using specialties as detailed on drawings, with at minimum isolation valves, unions, and P/T test ports supply and return, with control valve on return as specified.

3.4 FIELD QUALITY CONTROL

- A. Ensure Manufacturers provide:
 - 1. Thorough instruction of installing Contractor's personnel in installation of units.
 - 2. Instruction for Owner's personnel in operation and care of equipment.
 - 3. Maintenance brochure.
 - 4. Adjustment of air discharge pattern to suit each room as directed and approved.
- B. After installing equipment, inspect for damage to finish. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- C. Remove and replace malfunctioning and damaged units and retest as specified above.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 23 82 00

SECTION 26 05 00 – COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section and to all of Divisions 26.

1.2 SUMMARY

- A. Section Includes:
 - 1. General requirements applicable to components and systems included in Electric Contract.
- B. Products Installed but Not Furnished Under This Section
 - 1. Make electrical connections to equipment shown on Drawings and furnished by other Contractors. Obtain approved wiring diagrams and location drawings for roughing in and final connections from Contractor furnishing equipment.

1.3 REFERENCES

- A. AIA American Institute of Architects
- B. ADA Americans with Disabilities Act
- C. AISC American Institute of Steel Construction
- D. ANSI American National Standards Institute
- E. ASTM ASTM International
- F. IBC International Building Code
- G. IEEE Institute of Electrical and Electronics Engineers, Inc. (The)
- H. IES Illuminating Engineering Society of North America
- I. NEC National Electrical Code
- J. NEMA National Electrical Manufacturers' Association
- K. NETA International Electrical Testing Association
- L. NFPA National Fire Protection Association
- M. UL Underwriters' Laboratories, Inc.

1.4 SYSTEM DESCRIPTIONS

- A. Inspection of Existing Systems: Inspect each existing system scheduled for modification and issue a deficiency report to Owner and Architect listing conditions found prior to any removals, relocations, or additions. Modified systems include (but are not limited to):
 - 1. Power distribution.

2. Lighting.
 3. Emergency lighting.
- B. Design Requirements - Provide complete systems, properly tested, balanced, and ready for operation including necessary details, items and accessories although not expressly shown or specified, including (but not limited to):
1. Wiring and raceway for work specified in Project Manual and shown on Drawings.
 2. Electrical devices and equipment for work specified in Project Manual and shown on Drawings.
 3. Systems included, but not limited to:
 - a. Electrical distribution.
 - b. Electrical connections.
 - c. Lighting.
 - d. Emergency lighting.
 - e. Cafetorium Audio System
- C. Electric Layouts: Arrange panels; disconnect switches, enclosed breakers, equipment, raceways, and similar components neatly, orderly and symmetrically. Provide 3/4-inch fire treated, gray painted plywood backboards for surface mounted panels, disconnect switches, enclosed breakers, and similar equipment. Arrangements shown on Drawings are diagrammatic only; provide and adjust raceways, wiring, and other components as required.
- D. Power Interruptions and Scheduled Outages: Coordinate scheduling of all power interruptions and outages with Owner. Confirm with Owner prior to interruption of power, which building systems are considered critical and must remain operational during the interruption. If a scheduled power outage is to extend beyond one standard workday, provide temporary power to operate critical building systems (including, but not limited to fire alarm system, security system, building access control system, and building energy management control system).

1.5 SUBMITTALS

- A. General Division 26 submittal requirements:
1. Comply with requirements of SECTION 01 33 00 – SUBMITTAL PROCEDURES and as modified below.
 2. Product Data: Submit product data for items listed in individual technical section. Clearly identify manufacturer, pertinent design, function, materials, construction and performance data specifically addressing specification description and Contract Document requirements of item. Strike out products that are not applicable to item being submitted, where more than one product is indicated on manufacturer product literature.
 - a. Cover Sheet: Attach cover sheet, identified in Section 01 33 00, to Product Data of each item submitted. Provide cover sheet for only one type of item with related accessories, equipment with related components. Do not combine unrelated items under the same cover sheet.

- b. Specified Equivalent Product Data: Submit manufacturer's product information including product literature, technical specifications and descriptions, performance data and, and similar items to demonstrate compatibility with Basis-of-Design Equipment as specified in the "Part 2 – Products" of each technical section.
- 3. Shop Drawings: Submit detailed drawings for electrical equipment layouts, showing exact sizes and locations for approval before beginning work.
 - a. Do not proceed with installation of systems in each area until agreement is reached with all concerned on exact arrangements for each room or area, unless otherwise directed by Architect. If Contractor proceeds prior to resolving conflicts, Contractor shall modify installed Work as required to permit other systems to proceed with a coordinated installation.
 - b. Specified Equivalent Drawings: Submit detailed drawings of proposed Specified Equivalents, indicating proposed installation of equipment and showing maintenance clearances, required service removal space other pertinent revisions to arrangement and configuration shown in Contract Documents.
- 4. Samples: On all submittals, indicate standard factory color and factory finish surfaces. Where more than one color is available, selection will be made by Architect from manufacturer's full range of colors. Electronically transmitted color samples are not acceptable.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for penetration firestopping materials. Include ratings, furnished specialties and accessories.
 - 1. Penetration firestopping materials.
 - 2. Penetration firestopping assembly drawings.

1.7 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Codes and Standards: Comply with applicable Federal, State and local building and electrical codes, laws, ordinances, and regulations, and comply with applicable NFPA, National Electrical Code and utility company requirements and regulations. Provide Underwriters Laboratories Seal on all materials.
 - 2. Permits and Inspections: Obtain approvals, tests, and inspections required by Architect, Engineer, local electrical inspector, agent or agency specified in Project Manual, or National, State, or local codes and ordinances.
 - a. Schedule electrical inspection by an agency acceptable to the local authority having jurisdiction and submit final inspection certificate to Architect.

- b. Furnish materials and labor necessary for tests and pay costs associated with tests and inspections.
 - c. Conduct tests under load for load balancing and where required by codes, regulations, ordinances, or technical Specification.
- 3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for intended use.

1.8 DELIVERY, STORAGE AND HANDLING

A. Storage and Protection:

- 1. Take precautions to store materials and products to protect finishes and not permit dust and dirt to penetrate equipment.
- 2. Replace equipment damaged beyond reasonable repair as required by Architect.
- 3. Refinish any equipment with marks, stains, scratches, dents, and other aesthetic damage that doesn't impede operation of equipment as required by Architect.

1.9 COORDINATION OF WORK

A. New Construction:

- 1. Openings, Chases, Recesses, Sleeves, Lintels and Bucks (required for admission of Electric Contract systems and components): Coordinate requirements with General Contractor for inclusion in General Contract. Furnish necessary information (e.g. locations and sizes) to General Contractor in ample time for installation of systems and components included in Electric Contract.
- 2. Anchor Bolts: Deliver to Contractor responsible for General Work anchor bolts required for Electric Contract construction that are to be installed in construction included in General Contract.
- 3. Locate settings, check locations as installation in General Contract progresses, and provide templates or holding fixtures as required to maintain proper accuracy.

B. Existing Construction:

- 1. Unless otherwise specified, employ Contractor responsible for General Work for all cutting, patching, repairing, and replacing of general work required for installation of systems and components included in Electric Work. Secure approval from Architect's representative before cutting.
- 2. Anchor Bolts: Deliver to Contractor responsible for General Work anchor bolts required for Electric Work construction that are to be installed in construction included in General Contract. Provide templates or holding fixtures as required to maintain proper accuracy.

3. Access Doors: Provide access doors shown on Drawings, or as required for access to pull boxes, junction boxes, relays and other electrical devices requiring periodic inspection, adjustment or maintenance, where located above or within inaccessible walls or ceilings, and including cutting and patching of adjacent walls and ceilings to match existing materials and finishes.

1.10 ALTERATION PROCEDURES

- A. In locations where existing devices are indicated to be disconnected and removed and existing power circuit or communications cable is not scheduled to be reused:
 1. Remove circuit conductors back to source.
 2. Modify panel directory for that circuit.
 3. Remove all existing exposed and unexposed accessible raceway.
 4. Provide blank cover plates or wall infill (as indicated on plans) and as described below:
 - a. For single gang and multi-gang switch boxes in public or occupied spaces; stainless steel coverplates.
 - b. For single gang and multi-gang boxes in un-occupied spaces; stainless steel, galvanized steel or PVC coverplates.
 - c. For boxes larger than standard switch boxes in public or occupied spaces; remove existing box and provide wall infill, matching existing sub-surface and finished surface conditions. Paint wall to match surrounding finishes.
 - d. For boxes larger than standard switch boxes in un-occupied spaces; 18 gage galvanized sheet metal coverplate with machined edges. Prime and paint to match surrounding finish conditions.
 5. Patch and paint existing walls where disturbed by the electrical work.
- B. In locations where existing devices are to remain in place, ensure circuits feeding such devices remain operational. Modify existing circuits as required to allow new construction to occur and to maintain necessary circuitry to existing devices for complete and proper operation.
- C. In locations where entire existing system is being removed or modified:
 1. Refer to individual system specification sections for documentation and inspection requirements prior to any alteration work on any system.
 2. Take all necessary measures to ensure that down time will not compromise safety.
 3. Notify Owner, Architect and other Contractors not less than 2 weeks prior to interruptions in service.
 4. Coordinate work schedule to minimize duration of system outage during hours when building is occupied.

PART 2 - PRODUCTS

2.1 PENETRATION FIRESTOPPING

- A. Comply with requirements for sealants in fire rated penetrations specified in Section 07 84 13 "Penetration Firestopping".
- B. Submit Manufacturers Product Data Sheets for each type of product selected. Certify that Firestop Material is free of asbestos and lead paint and complies with local regulations.
 - 1. Certification by firestopping manufacturer that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs) and are nontoxic to building occupants.
- C. Submit system design listings, including illustrations from qualified testing and inspection agency that is applicable to each firestop configuration.

2.2 GROUT

- A. Description: ASTM C 1107, Grade B, non-shrink, non-metallic, high strength grout, suitable for interior and exterior, above and below grade applications.
 - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

2.3 SEALANTS

- A. Comply with requirements for sealants in non-fire rated penetrations specified in Section 07 92 00 "Joint Sealants."
- B. Mildew-Resistant, Single-Component, Acid-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. BASF Building Systems; Omniplus.
 - b. Dow Corning Corporation; 786 Mildew Resistant.
 - c. GE Advanced Materials - Silicones; Sanitary SCS1700.

2.4 ACCESS DOORS

- A. Comply with requirements for access doors specified in Section 08 31 13 "Access Doors and Frames" for product requirements.

2.5 PAINT AND FINISHES

- A. Refer to Division 09 for painting and finishing.

PART 3 - EXECUTION

3.1 CUTTING AND PATCHING

- A. Do not cut any vapor barriers or waterproofing for admission of any equipment or materials and do not pierce any structural members without written permission from Architect.
- B. Furnish and install sleeves, inserts, panels, raceways, boxes, and similar infrastructure., ahead of general construction work and maintain Contractor personnel at Site during installation of general construction work to be responsible for and to maintain these items in position.
- C. Unless otherwise noted elsewhere in Contract Documents, bear expense of cutting, patching, repairing or replacing of work of other trades made necessary by any fault, error or tardiness on part of Electrical Contract or damage done by Electric Contract. Employ and pay Contractor whose work is involved.

3.2 DEMONSTRATION OF COMPLETE ELECTRICAL SYSTEMS

- A. Thoroughly demonstrate and instruct Owner's designated representative in care and operation of electrical systems and equipment furnished and installed in Electric Contract.
 - 1. Factory Representative: In addition to demonstration and instruction specified above, provide technically qualified factory representatives from manufacturers of major equipment, to train Owner's representatives in care and operation of applicable products as specified in applicable technical sections of Division 26.
 - 2. Coordinate and schedule time and place of all training through the Architect at the Owner's convenience.
 - 3. Submit letters attesting to satisfactory completion of instructions, including date of completion of instruction, names of persons in attendance, and signature of Owner's authorized representative.
 - 4. Architect's representative must be present when Owner's representatives participate in instruction.

3.3 GROUTING

- A. Mix and install grout for electrical equipment base bearing surfaces, other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.

- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

3.4 SEALANTS

- A. Install sealants according to the requirements specified in Section 07 92 00 "Joint Sealants."

3.5 FIRESTOPPING

- A. Install firestopping according to the requirements specified in Section 07 84 13 "Penetration Firestopping."
- B. Applied Fireproofing:
 - 1. Coordinate the installation of hangers, supports and accessories from the structural steel with the fireproofing installation. Install all hangers and supports prior to installation of fireproofing.
 - 2. Repair or replace existing fireproofing removed as a part of Electrical Work installation.
 - a. Employ the services of an approved fireproofing contractor to repair or replace the fireproofing by patching any areas that have been removed or damaged due to the installation of work after the completion of the fireproofing.
- C. Repaired or replacement fireproofing shall match the fireproofing adjacent to the repaired area. All warranties shall be maintained.

3.6 ACCESS DOORS

- A. Install access doors according to the requirements specified in Section 08 31 13 "Access Doors and Frames."

END OF SECTION 26 05 00

SECTION 26 05 01 – HAZARDOUS MATERIAL DISPOSAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section and to all of Divisions 26.

1.2 SUMMARY

- A. Section Includes:

- 1. Selective removal and subsequent off-site disposal of the following hazardous waste:
 - a. PCB containing light ballasts.
 - b. Mercury containing fluorescent light tubes.
- 2. Requirements for transport and disposal of hazardous waste materials by legal and appropriate means.

1.3 REFERENCES

- A. Regulatory Requirements

- 1. United States Environmental Protection Agency (EPA)
 - a. 40 CFR 260 - Hazardous waste management system: General
 - b. 40 CFR 261 - Identification and Listing of Hazardous Waste.
 - c. 40 CFR 262 - Standards Applicable to Generators of Hazardous Waste.
 - d. 40 CFR 263 - Standards Applicable to Transporters of Hazardous Waste
 - e. 40 CFR 264 - Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
 - f. 40 CFR 265 - Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
 - g. 40 CFR 266 - Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities
 - h. 40 CFR 268 - Land Disposal Restrictions
 - i. 40 CFR 270 - EPA Administered Permit Programs: The Hazardous Waste Permit Program
 - j. 40 CFR 761 - Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution In Commerce, and Use Prohibitions.
- 2. United States Department of Transportation (DOT)
 - a. 49 CFR 171 - General Information, Regulations, and Definitions.
 - b. 49 CFR 172 - Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements.

- c. 49 CFR 173 - Shippers - General Requirements for Shipments and Packaging.
- d. 49 CFR 174 - Carriage by Rail.
- e. 49 CFR 175 - Carriage by Aircraft.
- f. 49 CFR 176 - Carriage by Vessel.
- g. 49 CFR 177 - Carriage by Public Highway.
- h. 49 CFR 178 - Specifications for Packaging.
- i. 49 CFR 179 - Specifications for Tank Cars.
- j. 49 CFR 180 - Continuing Qualification for Maintenance of Packaging.

3. New York State Department of Environmental Conservation (DEC)

- a. 6 NYCRR 360 - Solid Waste Management Facilities
- b. 6 NYCRR 364 - Waste Transporter Permits
- c. 6 NYCRR 370 - Hazardous Waste Management System: General.
- d. 6 NYCRR 371 - Identification and Listing of Hazardous Wastes.
- e. 6 NYCRR 372 - Hazardous Waste Manifest System and Related Standards for Generators, Transporters and Facilities.
- f. 6 NYCRR 373-1 - Hazardous Waste Treatment, Storage and Disposal Facility Permitting Requirements.
- g. 6 NYCRR 373-2 - Final Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities.
- h. 6 NYCRR 373-3 - Interim Status Standards for Owners and Operators of Hazardous Waster Facilities.
- i. 6 NYCRR 376 - Land Disposal Restrictions.

1.4 DEFINITIONS

- A. Remove: Remove and legally dispose of items except those indicated to be reinstalled, salvaged, or to remain Owner's property.

1.5 PROJECT SITE

A. Existing Conditions

- 1. Building Occupancy: Owner will occupy portions of building immediately adjacent to areas of hazardous material removal operations. Conduct removal operations in manner that will minimize need for disruption of Owner's normal operations. Provide minimum of 72 hours advance notice to Owner of removal activities that will affect Owner's normal operations.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- A. Labeling and Packaging Materials: Provide labeling and packaging materials as required by 49 CFR 173 Shippers - General Requirements for Shipments and Packaging.

- B. Hazardous Waste Disposal Vehicles: Provide vehicles for transporting hazardous waste possessing valid Industrial Waste Hauler Permit and equipped with appropriate placards affixed as prescribed by United States Department of Transportation regulations.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Examine conditions under which hazardous material disposal is to be conducted and notify affected Contractors and Architect in writing of any conditions detrimental to proper and timely hazardous material disposal. Do not proceed with disposal until unsatisfactory conditions have been corrected.

3.2 REMOVAL, PACKAGING, TRANSPORTATION AND DISPOSAL PROCEDURES

- A. Removal: Remove light ballasts and fluorescent light tubes whole and intact. Do not release PCBs or mercury to the environment.
- B. Packaging: Package, label, and mark all hazardous waste materials in accordance with applicable requirements of 49 CFR 173, 178 and 179.
- C. Temporary On-Site Storage and Protection: Provide storage on site of hazardous materials removed from service and scheduled for disposal to prevent damage or vandalism.
- D. Temporary On-Site Storage and Protection: Provide storage on site of hazardous materials removed from service and scheduled for disposal complying with requirements of 6 NYCRR 372.2 (a) (8). Do not exceed 180 days storage on site.
- E. Disposal - Transport hazardous waste to treatment or disposal facility that:
 - 1. Is permitted, licensed or registered by state to dispose of hazardous waste;
 - 2. Has interim status to dispose of hazardous waste;
 - 3. Is authorized to manage hazardous waste under Resource Conservation and Recovery Act (RCRA) or
 - 4. Is facility which:
 - a. Beneficially uses or reuses, or legitimately recycles or reclaims its waste; or
 - b. Treats its waste prior to beneficial use or reuse, or legitimate recycling or reclamation.

3.3 ADJUSTING/CLEANING

- A. At least weekly, remove from building site debris, rubbish, and other materials resulting from hazardous material disposal operations.

1. If additional hazardous materials are encountered during hazardous material disposal operations, comply with applicable regulations, laws, and ordinances concerning removal, handling, and protection against exposure or environmental pollution.
2. Burning of removed materials not permitted on Project Site.
3. Transport materials removed and legally dispose off-site.

END OF SECTION 26 05 01

SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Building wires and cables rated 2000 V and less.
2. Wires and cables for PV systems rated 2000 V and less.
3. Connectors, splices, and terminations rated 2000 V and less.

- B. Related Requirements:

1. Section 271500 "Communications Horizontal Cabling" for cabling used for voice and data circuits.

1.3 DEFINITIONS

- A. VFC: Variable-frequency controller.

1.4 CLOSEOUT SUBMITTALS

- A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Alcan Products Corporation; Alcan Cable Division.
 2. American Insulated Wire Corp.; a Leviton Company.
 3. General Cable Corporation.
 4. Senator Wire & Cable Company.
 5. Southwire Company.

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- D. Comply with UL 1277, UL 1685, and NFPA 70 for Type TC-ER cable used in VFC circuits.
- E. Conductors: Copper complying with NEMA WC 70/ICEA S-95-658.
 - 1. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Type THHN/THWN-2 and Type XHHW-2.
 - 2. PV Conductor Insulation: Comply with UL 4703.
- F. Cable: Comply with NEMA WC 70/ICEA S-95-658 for metal-clad cable, Type MC with ground wire.
 - 1. VFC Cable: Type TC-ER VFD with oversized crosslinked polyethylene insulation, spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire, and sunlight- and oil-resistant outer PVC jacket.

2.2 CONNECTORS AND SPLICES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Hubbell Power Systems, Inc.
 - 3. O-Z/Gedney; EGS Electrical Group LLC.
 - 4. 3M; Electrical Products Division.
 - 5. Tyco Electronics Corp.
 - 6. Ideal Industries/Buchanan
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 1. Conductors No. 8 AWG and smaller: Screw on, wing nut wire connectors with fixed square wire threads and wide throated skirt. UL 486C Listed.
 - 2. Conductors No. 6 AWG to 3/0 AWG: Bolt on type or crimped type compression, seamless copper connectors using hand or hydraulic tool, color coded to wire size. Connector shall be electro-tin plated to resist electrolytic corrosion. UL 486A and UL 486B Listed.
 - 3. Conductors No. 4/0 AWG and larger: Compression type solderless connector, long barrel seamless copper with minimum 2 pressure points per conductor. Fully compatible with industry standard crimping tool-die sets. Color coded to wire size and electro-tin plated to resist electrolytic corrosion. UL 486A Listed.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper; stranded.
- B. Branch Circuits: Copper, stranded.
- C. VFC Output Circuits Cable: Extra-flexible stranded for all sizes.
- D. PV Circuits: Copper; stranded.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type XHHW-2, single conductors in raceway.
- B. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN/THWN-2, single conductors in raceway.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway.
- E. Feeders Installed below Raised Flooring: Type THHN/THWN-2, single conductors in raceway.
- F. Feeders in Cable Tray: Metal-clad cable, Type MC.
- G. Exposed Branch Circuits, Including in Crawlspace: Type THHN/THWN-2, single conductors in raceway
- H. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway.
- I. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway
- J. Branch Circuits Installed below Raised Flooring: Metal-clad cable, Type MC.
- K. Branch Circuits in Cable Tray: Metal-clad cable, Type MC.
- L. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- M. VFC Output Circuits: Type TC-ER cable with braided shield.
- N. PV Circuits: Type PV for PV source circuits.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Wire and Cable Installation: Install all wire and cable in approved raceway with exit light circuits, emergency lighting circuits, and special systems wiring installed in separate raceways. Use UL approved lubricants for wire pulling. Tag all feeders, subfeeders, special system wiring and branch circuit wiring at each pull box, junction box, and gutter space indicating point of origin and termination. Install green grounding wire in all raceways for connection to equipment, motors, transformers, and similar equipment. Install low voltage cables as detailed in individual sections.
- B. Splices and Terminations: Make all splices accessible. Insulate all splices, taps, and connections to insulation value of conductor. Follow all instructions and recommendations of splice material manufacturer. Terminate low voltage cables with termination blocks as described in individual sections.

1. Common Neutral Conductor: Do not use common neutral for multiple branch circuits.
- C. Pull all conductors together where more than one is being installed in raceway.
- D. Do not exceed maximum pulling tension of wire being installed. Use pulling compound or lubricant, where necessary. Use compound that will not deteriorate conductor or insulation.
- E. Use pulling means, including fish tape, cable or rope that cannot damage raceway or wire.
- F. Replace wiring damaged during installation.
- G. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."
- H. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- I. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- J. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- K. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.
- L. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- M. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."
- N. Metal Clad Type "MC" Cable:
 1. Install MC cable, parallel and perpendicular to surfaces or structural members following surface contours, where possible.
 2. Do not use MC cable for home runs (from panel to first device in branch circuit).
 3. Do not install exposed metal clad cable in any areas, including mechanical and electrical spaces.
 4. Do not penetrate floor slabs with MC cable.
 5. Metal clad cable may be used for switch, receptacle, light fixture, device and fixture branch circuit wiring above ceilings and in walls beyond corridor walls.
 6. MC cable shall include a neutral, whether used or not, to a light switch location.
 7. Above corridor ceilings, use MC cable for 6 foot light fixture whips.

8. Maintain a clearance of at least 6 inches from hot water and other high temperature pipes and telecommunications conduits, and at least 12 inches from unshielded telecommunications cables.
9. Support MC cable every 6 feet, and within 1 foot of every box, fitting, and cable termination. Do not support MC cable on hung ceilings or on ceiling support wires. The use of cable ties to support MC cable is prohibited.
10. Use MC cable in branch circuit wiring in movable metal partitions and movable gypsum partitions. Install conductors in accordance with partition manufacturer's recommendations.

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.
- D. Splices:
 1. Dry Locations:
 - a. Conductors No. 8 AWG or Smaller: Use spring type pressure connectors or indent type pressure connectors with insulating jackets (except where special type splices are required).
 - b. Conductors No. 6 AWG or Larger: Use un-insulated indent type pressure connectors. Fill indentations with electrical filler tape and apply insulation tape to insulation equivalent of the conductor, or insulate with heat shrinkable splices.
 - c. Gutter Taps in Panelboards: Install gutter tap, fill indentations with electrical filler tape and apply insulation tape to insulation equivalent of the conductor, or insulate with gutter tap cover.
 2. Damp Locations: As specified for dry locations, except apply moisture sealing tape over entire insulated connection (moisture sealing tape not required if heat shrinkable splices are used).
 3. Wet Locations: Use un-insulated indent type pressure connectors and insulate with resin splice kits or heat shrinkable splices. Exception: Totally enclosed splices above ground protected in NEMA 3R, 4, 4x enclosures may be spliced as specified for damp locations.

E. Terminations:

1. Conductors No. 10 AWG or Smaller - Use terminals for:
 - a. Connecting control and signal wiring to terminal strips.
 - b. Connecting wiring to equipment designed for use with terminals.
 2. Conductors No. 8 AWG or Larger - Use compression or mechanical type lugs for:
 - a. Connecting cables to flat bus bars.
 - b. Connecting cables to equipment designed for use with lugs.
 3. For Conductor Sizes Larger than Terminal Capacity on Equipment: Reduce larger conductor to maximum conductor size that terminal can accommodate (reduced section not longer than one foot). Use compression or mechanical type connectors suitable for reducing connection.
- F. Provide insulated green ground conductor for each branch and feeder circuit.
- G. All connections and terminations installed according to manufacturer's recommendations.
- H. All bolted or screw-type terminations specifically torqued to setting specified by manufacturer.

3.5 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
2. Perform each of the following visual and electrical tests:
 - a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
 - b. Test bolted connections for high resistance using the following:
 - 1) A low-resistance ohmmeter.
 - 2) Calibrated torque wrench.
 - 3) Thermographic survey after electrical system activation and is under load.
 - c. Inspect compression applied connectors for correct cable match and indentation.
 - d. Inspect for correct identification.
 - e. Inspect cable jacket and condition.
 - f. Insulation-resistance test on each conductor with respect to ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
 - g. Continuity test on each conductor and cable.
 - h. Uniform resistance of parallel conductors.
3. Initial Infrared Scanning: Before Substantial Completion, perform an infrared scan of each splice and termination in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.
 - a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - b. Record of Infrared Scanning: Prepare a certified report that identifies splices and terminations checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
4. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice and termination 11 months after date of Substantial Completion.

B. Cables will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports to record the following:

1. Procedures used.
2. Results that comply with requirements.
3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

END OF SECTION 26 05 19

SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Grounding and bonding systems and equipment.
- B. Section includes grounding and bonding systems and equipment, plus the following special applications:
 - 1. Underground distribution grounding.
 - 2. Foundation steel grounding.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

1.4 INFORMATIONAL SUBMITTALS

- A. As-Built Data: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:
 - 1. Ground rods.
 - 2. Ground rings.
 - 3. Grounding arrangements and connections for separately derived systems.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Instructions for periodic testing and inspection of grounding features at test wells, ground rings and grounding connections for separately derived systems based on NETA MTS.

- 1) Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
 - 2) Include recommended testing intervals.
- B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

2.2 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 1. Solid Conductors: ASTM B 3.
 2. Stranded Conductors: ASTM B 8.
 3. Tinned Conductors: ASTM B 33.
 4. Bonding Cable: No. 6, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
- C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 inch thick by 2 inches wide by 8 inches long (6.3 by 50 mm by 200 mm), with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V. fiberglass reinforced polyester, impulse tested at 5000 V.

2.3 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.
 - 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- D. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless, non-reversible compression or exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
- E. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.
- F. Cable-to-Cable Connectors: Non-reversible compression or exothermic-type, copper or copper alloy.
- G. Conduit Hubs: Mechanical type, terminal with threaded hub.
- H. Ground Rod Clamps: Non-reversible compression or exothermic-type, copper or copper alloy.
- I. Lay-in Lug Connector: Mechanical type, copper rated for direct burial terminal with set screw.
- J. Service Post Connectors: Mechanical type, bronze alloy terminal, in short- and long-stud lengths, capable of single and double conductor connections.

2.4 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad, sectional type; 10 feet by 3/4 inch (3 m by 19 mm) in diameter.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install stranded conductors for all sizes unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum unless indicated otherwise on drawings.
 - 1. Bury at least 24 inches below grade.
- C. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.

- D. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus on insulated spacers 2 inches (50 mm) minimum from wall, 6 inches (150 mm) above finished floor unless otherwise indicated.
 - 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.
- E. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Handholes: Install a driven ground rod through handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. . Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.
- C. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.

3.3 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1. Feeders and branch circuits.
 - 2. Lighting circuits.
 - 3. Receptacle circuits.
 - 4. Single-phase motor and appliance branch circuits.
 - 5. Three-phase motor and appliance branch circuits.

6. Flexible raceway runs.
 7. Armored and metal-clad cable runs.
 8. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
- C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
 - D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
 - E. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a grounding system complying with requirements in TIA/ATIS J-STD-607-A.
 1. For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
 2. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-4-by-12-inch grounding bus.
 3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
 - F. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.
 - G. Metallic Fences: Comply with requirements of IEEE C2.
 1. Grounding Conductor: Bare, tinned copper, not less than No. 8 AWG.
 2. Gates: Shall be bonded to the grounding conductor with a flexible bonding jumper.
 3. Barbed Wire: Strands shall be bonded to the grounding conductor.

3.4 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
 2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- D. Grounding and Bonding for Piping:
1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- E. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.
- F. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around the perimeter of building.
1. Install tinned-copper conductor not less than No. [2/0] AWG for ground ring and for taps to building steel.
 2. Bury ground ring not less than 24 inches from building's foundation.
- G. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; use a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.
1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.

2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

3.5 LABELING

- A. Comply with requirements in Division 26 Section "Identification for Electrical Systems" Article for instruction signs. The label or its text shall be green.
- B. Install labels at the telecommunications bonding conductor and grounding terminal bar and at the grounding electrode conductor where exposed.
 1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

3.6 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at individual ground rods. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
 4. Prepare dimensioned Drawings locating each ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- B. Grounding system will be considered defective if it does not pass tests and inspections.
- C. Prepare and submit all test and inspection reports
- D. Report measured ground resistances that exceed the following values:
 1. Power and Lighting Equipment or System with Capacity to 1000 kVA: 5 ohms.

2. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
 3. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).
 4. Pad-Mounted Equipment: 5 ohms.
- E. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.
- F. Provide all test and inspection reports with closeout submittals.

END OF SECTION 26 05 26

SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- C. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 QUALITY ASSURANCE

- A. Comply with NFPA 70.

1.6 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with Division 3 section 'Cast-in-Place Concrete'.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut; Tyco International, Ltd.
 - g. Wesanco, Inc.
 - 2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 - 4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 - 5. U-Channel Strut Systems: Provide 16 gauge steel U-channel strut system for supporting electrical equipment of types and sizes indicated with 9/16-inch diameter holes at 8 inches on center on top surface, with standard galvanized or PVC finish and following fittings that mate and match with U-channel:
 - a. Fixture hangers.
 - b. Channel hangers
 - c. End caps
 - d. Beam clamps
 - e. Wiring stud.
 - f. Thin-wall raceway clamps.
 - g. Rigid conduit clamps.
 - h. Raceway hangers.
 - i. U-bolts.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Hilti Inc.
 - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened Portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
 3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 6. Toggle Bolts: All-steel springhead type.
 7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

2.3 MANUFACTURED SUPPORTING DEVICES

- A. General: Provide supporting devices, complying with manufacturer's standard materials, design and construction in accordance with published product information, and as required for complete installation, and as specified in this Section. Where more than one type of device meets indicated requirements, select device according to Contractor's option.

1. Fasteners:

- a. Standard Bolts and Nuts: ASTM A 307, Grade A, regular hexagon head.
- b. Lag Bolts: FS FF-B-561, square head type.
- c. Machine Screws: FS FF-S-92, cadmium plated steel.
- d. Machine Bolts: FS FF-B-584 heads; FF-N-836 nuts.
- e. Wood Screws: FS FF-S-111 flat head carbon steel.
- f. Plain Washers: FS FF-W-92, round, general assembly grade carbon steel.
- g. Lock Washers: FS FF-W-84, helical spring type carbon steel.
- h. Toggle Bolts: Tumble-wing type; FS FF-B-588, type, class and style as required to sustain load.
- i. Stainless Steel Fasteners: Type 302 for interior Work; Type 316 for exterior Work.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least **25** percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with single-bolt conduit clamps.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.
- E. Install hangers, supports, clamps and attachments to support raceway properly from building structure. Arrange for grouping of parallel runs of horizontal raceways to be supported together on trapeze type hangers where possible.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- D. Fasteners
 - 1. Materials:
 - a. Dry Locations: Use cadmium or zinc coated anchors and fasteners.
 - b. Damp and Wet Locations: Use hot dipped galvanized or stainless steel anchors and fasteners.
 - c. Corrosive Atmospheres Or Other Extreme Environmental Conditions: Use fasteners made of materials suitable for conditions.
 - 2. Types (unless otherwise specified or indicated):
 - a. Use cast-in-place concrete inserts in fresh concrete construction for direct pull-out loads such as shelf angles or fabricated metal items and supports attached to concrete slab ceilings.
 - b. Use anchoring devices to fasten items to solid masonry and concrete when anchor is not subjected to pull out loads, or vibration in shear loads.
 - c. Use toggle bolts to fasten items to hollow masonry and stud partitions.
- E. Attachment Devices
 - 1. Make attachments to structural steel or steel bar joists wherever possible. Provide intermediate structural steel members where required by support spacing.
 - 2. Make attachments to steel bar joists at panel points of joists.
 - 3. Do not drill holes in main structural steel members.
 - 4. Use "C" beam clamps for attachment to steel beams
 - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 - 6. To Light Steel: Sheet metal screws.

7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate
8. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

F. Raceway Support

1. Use pipe straps and specified method of attachment where raceway is installed proximate to surface of masonry construction.
2. Use hangers secured to surface with specified method of attachment where raceway is suspended from the surface.
3. Use "C" beam clamps and hangers where raceway is supported from steel beams.
4. Use channel support system supported from structural steel for multiple parallel raceway runs.
5. Where raceways are installed above ceiling, do not rest raceway directly on runner bars, T-bars, etc.
 - a. Raceway Sizes 2-1/2 Inches and Smaller: Support raceway from ceiling supports or from construction above ceiling.
 - b. Raceway Sizes Over 2-1/2 Inches: Support raceway from beams, joists, or trusses above ceiling.

G. Luminaire Support

1. Do not support luminaires from ceilings or ceiling supports unless specified or indicated on Drawings.
 - a. Comply with NEC, Article 410.36 – Means of Support.
 - b. Support luminaires with hanger rods attached to beams, joists, or trusses-of largest standard diameter-that fits in mounting holes of fixture.
 - c. Where approved, channel supports may span and rest upon lower chord of trusses and be used to support luminaires.
 - d. Where approved, channel supports may span and be attached to underside of beams, joists, or trusses and be used to support luminaires.
2. Use 2 nuts and 2 washers on lower end of each hanger rod to hold and adjust fixture (one nut and washer above top of fixture housing, one nut and washer below top of fixture housing).
 - a. Where adequately supported outlet box is specified to support fixture or be used as one point of support, support box so that box may be adjusted to bring face of outlet box even with surface of ceiling.

3. Ceiling Mounted Luminaires: Provide at least following number of supports with additional supports when recommended by fixture manufacturer or shown on Drawings.
 - a. Support individual luminaires less than 2 feet long at 2 points.
 - b. Support continuous row luminaires less than 2 feet wide at points equal to number of luminaires plus one. Uniformly distribute points of support over row of fixtures.
 - c. Support individual luminaires 2 feet or wider at 4 corners.
 - d. Support continuous row luminaires 2 feet or wider at points equal to twice number of luminaires plus 2. Uniformly distribute points of support over row of fixtures.
 - e. Use adequately supported outlet box as one point of support for luminaires weighing less than 50 pounds.
 - f. Support recessed mounted luminaires directly from suspension system of suspended acoustical ceilings and securely fasten luminaires to framing members of ceiling using lock clips, wirelashing or leveling supports. Support each fixture weighing more than 50 pounds (including lamps) independent of suspended ceiling grid.
4. Wall Mounted Luminaires: Provide at least following number of supports with additional supports when recommended by fixture manufacturer or shown on Drawings.
 - a. Support individual luminaires 2 feet long or less at 2 points.
 - b. Support individual luminaires over 2 feet long at 3 points.
 - c. Support continuous row luminaires at points equal to twice number of fixtures. Uniformly distribute points of support.
 - d. Adequately supported outlet box may be used as one point of support for luminaires weighing less than 50 pounds

H. Channel Support System: Channel supports may be used, as approved, to accommodate mounting of equipment with following material and finish.

1. Dry Locations: 16-gage steel channel support system with standard finish.
2. Damp and Wet Locations: 16-gage steel channel support system with hot dipped galvanized or PVC finish

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 5 – Metal Fabrications for site fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions for approved equipment but not less 4 inches (100 mm) larger in both directions than the supported unit. Anchors will be a minimum of 10 bolt diameters from the edge of the base.
- B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 3 Cast-in –Place Concrete OR as required per equipment manufacturer’s recommendations.
- C. Anchor equipment to concrete base:
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer’s setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 3. Install anchor bolts according to anchor-bolt manufacturer’s written instructions.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 26 05 29

SECTION 26 05 33 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
- B. Related Sections include the following:
 - 1. Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. ENT: Electrical nonmetallic tubing.
- C. EPDM: Ethylene-propylene-diene terpolymer rubber.
- D. FMC: Flexible metal conduit.
- E. GRC: Galvanized rigid steel conduit
- F. LFMC: Liquidtight flexible metal conduit.
- G. LFNC: Liquidtight flexible nonmetallic conduit.
- H. NBR: Acrylonitrile-butadiene rubber.
- I. RNC: Rigid nonmetallic conduit.

1.4 ACTION SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets, custom enclosures, cabinets, handholes and boxes.
 - 1. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT, TUBING AND FITTINGS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. AFC Cable Systems, Inc.
 2. Alflex Inc.
 3. Allied Tube & Conduit; a Tyco International Ltd. Co.
 4. Anamet Electrical, Inc.; Anaconda Metal Hose.
 5. Electri-Flex Co.
 6. O-Z Gedney; a unit of General Signal.
 7. Wheatland Tube Company.
- B. Galvanized Rigid Steel Conduit (GRC): Rigid, hot dipped galvanized steel with galvanized threaded malleable iron fittings and bushings with insulated throat (galvanized steel). ANSI C80.1 and UL 6.
- C. Electrical Metallic Tubing (EMT): Metallic galvanized steel tube with galvanized steel compression or setscrew type fittings and bushings with insulated throat (galvanized steel). ANSI C80.3 and UL 797.
- D. Flexible Metal Conduit (FMC): Flexible, interlocked aluminum metal strip with galvanized screw-in type steel fittings. UL 1.
- E. Liquid Tight Flexible Metal Conduit (LFMC) : Liquid-tight flexible metal raceway with single, flexible, continuous, interlocked and double-wrapped steel core galvanized inside and outside, coated with liquid tight jacket of flexible polyvinyl chloride (PVC). UL 360.
- F. Fittings:
1. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 2. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
 3. Fittings for EMT:
 - a. Material: Steel .
 - b. Type: Setscrew or compression.
 4. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
- G. Joint Compound for Rigid Steel Conduit: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 NONMETALLIC CONDUIT AND TUBING

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - 3. Arnco Corporation.
 - 4. CANTEX Inc.
 - 5. CertainTeed Corp.; Pipe & Plastics Group.
 - 6. Condux International, Inc.
 - 7. ElecSYS, Inc.
 - 8. Electri-Flex Co.
 - 9. Lamson & Sessions; Carlon Electrical Products.
 - 10. Manhattan/CDT/Cole-Flex.
 - 11. Thomas & Betts Corporation.
 - 12. RACO; a Hubbell Company.
- B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. RNC: NEMA TC 2, UL 651, Type EPC-40-PVC, with matching fittings by same manufacturer as the conduit.
- D. ENT: Comply with NEMA TC 13 and UL 1653.
- E. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
- F. LFNC: UL 1660.
- G. Fittings for LFNC: UL 514B.
- H. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 OPTICAL FIBER/COMMUNICATIONS CABLE RACEWAY AND FITTINGS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Arnco Corporation.
 - 2. Endot Industries Inc.
 - 3. IPEX Inc.
 - 4. Lamson & Sessions; Carlon Electrical Products.
- B. Description: Comply with UL 2024; flexible type, approved for plenum installation.

2.4 METAL WIREWAYS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Cooper B-Line, Inc.
 - 2. Hoffman.
 - 3. Square D; Schneider Electric.
- B. Description: Sheet metal sized and shaped as indicated, UL 870 and NEMA 250, Type 1, 12, 3R, as indicated.
- C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Hinged type or as indicated with manufacturer's standard enamel finish.

2.5 SURFACE RACEWAYS

- A. Listing and Labeling: Surface raceways shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected by Architect.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Hubbell, Inc.
 - b. Thomas & Betts Corporation.
 - c. Walker Systems, Inc.; Wiremold Company (The).
 - d. Wiremold Company (The); Electrical Sales Division.
- C. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Butler Manufacturing Company; Walker Division.
 - b. Enduro Systems, Inc.; Composite Products Division.
 - c. Hubbell Incorporated; Wiring Device-Kellems Division.
 - d. Lamson & Sessions; Carlon Electrical Products.
 - e. Panduit Corp.
 - f. Walker Systems, Inc.; Wiremold Company (The).
 - g. Wiremold Company (The); Electrical Sales Division.

2.6 BOXES, ENCLOSURES, AND CABINETS

- A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
 - 2. EGS/Appleton Electric.
 - 3. Erickson Electrical Equipment Company.
 - 4. Hoffman.
 - 5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
 - 6. O-Z/Gedney; a unit of General Signal.
 - 7. RACO; a Hubbell Company.
 - 8. Robroy Industries, Inc.; Enclosure Division.
 - 9. Scott Fetzer Co.; Adalet Division.
 - 10. Spring City Electrical Manufacturing Company.
 - 11. Thomas & Betts Corporation.
 - 12. Walker Systems, Inc.; Wiremold Company (The).
 - 13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.
- C. Outlet Boxes
 - 1. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
 - 2. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
 - 3. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
 - 4. Materials
 - a. Recessed Applications and Exposed Applications in Unfinished Spaces: Galvanized, stamped steel.
 - b. Boxes in stud walls shall be 4" square, 2 1/8" deep boxes with raised covers for power circuits. Provide "Far-Side" box support to keep box alignment parallel with wall face.
 - c. Boxes in masonry walls shall be 3 1/2" deep masonry boxes, single or multigang as required
 - d. Exposed Applications: In finished spaces requiring exposed applications, provide boxes to match surface raceway system. In situations where surface mount conduits are allowed, conduit style boxes shall be used. Where surface mount devices are provided as components of specific systems, provide surface mount box from same manufacturer to match device.
 - e. Concrete and Wall in Wet Locations: Heavy duty cast aluminum, thermoset protective silver grey finish, with threaded mounting posts.

- f. Weatherproof Outlet Boxes: Corrosion-resistant cast metal weatherproof outlet wiring boxes of appropriate type, shape, size and depth, with threaded conduit ends and cast metal face plates with cover suitably configured for each application; and including face plate gaskets and corrosion resistant fasteners. Do not compromise outlet weatherproof integrity when attachment plug is inserted.
 - g. Junction and Pull Boxes: Galvanized code gauge sheet steel boxes with screw-on covers, of appropriate type, shape and size suitable for box location and installation with welded seams and equipped with stainless steel nuts, bolts, screws and washers.
- 5. Size: As required for number and size of raceways and conductors. Depth to suit wall depth and device installed.
- 6. Covers: Design and style for each type, outlet, junction box, etc.; NEMA rated for each location.
- D. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Nonmetallic Enclosures: Plastic.
- E. Cabinets:
 - 1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2. Hinged door in front cover with flush latch and concealed hinge.
 - 3. Key latch to match panelboards.
 - 4. Metal barriers to separate wiring of different systems and voltage.
 - 5. Accessory feet where required for freestanding equipment.
- F. Metal Floor Boxes:
 - 1. Material: sheet metal.
 - 2. Type: Fully adjustable.
 - 3. Shape: Rectangular.
 - 4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- G. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb (23 kg). Outlet boxes designed for attachment of luminaires weighing more than 50 lb (23 kg) shall be listed and marked for the maximum allowable weight.
- H. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Raceway Installation: Securely support raceway from building construction, separately from outlet boxes and junction boxes. Secure to masonry surfaces with expansion anchors. Use galvanized hanger rods, inserts and hangers. Conceal all raceway runs except in mechanical rooms, storage room ceilings, and areas above suspended ceilings. Run exposed raceway neatly, parallel and level, to ceilings, walls and floors. Make necessary offsets and bends to comply with construction. Install expansion fittings at all building expansion joints. Support all raceways with clamps per National Electric Code
1. GRC Installation: Use GRC in concrete slabs, below concrete slabs, below grade, damp locations, exterior locations and in hazardous locations. Where exposed leaving concrete slabs, extend minimum 6 inches above and below slabs. Use GRC elbows when penetrating concrete slab from PVC raceway below or in slabs.
 2. RNC: Use for underground applications, in slabs, and below slabs. Provide rigid raceway when extending through slabs. Install in accordance with requirements of Article 352 of NEC. Make solvent-cemented joints in accordance with recommendations of manufacturer.
 3. EMT: Use EMT for non-hazardous, dry locations above grade. As a minimum, use EMT in corridor ceilings, for home runs and in all unoccupied exposed interior areas. Surface mounted EMT shall not be used in finished areas without written permission from the Architect or Owner.
 4. FMC: Use flexible metal conduit for final connections to motors, step-down transformers, vibrating machines, etc. Terminate with clamp type connectors and anti-short bushing. Maximum length of three feet.
 5. LFMC: Use a maximum of two feet of liquid tight flexible conduit for connection of motors and for other electrical equipment where subject to movement and vibration and also where subjected to one or more of the following conditions:
 - a. Exterior location.
 - b. Moist or humid atmosphere where condensate can be expected to accumulate.
 - c. Corrosive atmosphere.
 - d. Subjected to water spray.
 - e. Subjected to dripping oil, grease or water
 6. LFNC: Use a maximum of three feet of liquid tight flexible nonmetallic conduit for connection to video cameras and other electrical equipment with extreme bending requirements and also where subjected to one or more of the following conditions:
 - a. Exterior location.
 - b. Corrosive atmosphere.
 7. All non-metallic or flexible conduit shall contain a separate grounding conductor in addition to the circuit conductors.

8. Complete raceway installation before starting conductor installation.
9. Do not secure branch circuit wiring to ceiling support wires. Provide independent support wires dedicated only to electrical raceways.
10. Use roughing-in dimensions of electrically operated units furnished by supplier. Set conduit and boxes for connection to units only after receiving dimensions and after checking location with other trades.
11. Provide nylon pull cord in empty raceways. Test empty raceways with ball mandrel. Clear any raceway that rejects ball mandrel. Restore raceway and surrounding surfaces to original condition.
12. Fasten raceway terminations in sheet metal enclosures by 2 locknuts and terminate with bushing. Install locknuts inside and outside of enclosure.
13. Do not cross pipe shafts or ventilating duct openings with raceways.
14. Keep raceways at least 6 inches from parallel runs of flues, hot water pipes or other sources of heat. Wherever possible, install horizontal raceway runs above water and steam piping.

B. Concealed Raceways

1. Paint raceway threads in metallic raceways installed underground, in floors below grade, or outside with corrosion-inhibiting compound before assembling couplings. Draw coupling and raceway sufficiently tight to ensure water tightness.
2. For floors-on-grade, install raceways under concrete slabs.
3. Install underground raceways minimum of 18 inches below finished grade.
4. Provide raceway in furniture and any other cavity to effectively create a raceway system from the ceiling space to the outlet.
5. Stub-ups to Above Recessed Ceilings:
 - a. Use EMT for raceways.
 - b. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

C. Raceways in Concrete Slabs: Do not embed pipes other than electrical raceway in structural concrete and provide steel sleeves for raceway passing through concrete. Obtain Architect's approval for any variation from following requirements unless shown on Drawings. Request Architect's approval in writing accompanied by suitable sketch.

1. Place raceways between bottom reinforcing steel and top reinforcing steel.
2. Place raceways either parallel or at 90 degrees to main reinforcing steel.
3. Place nearly parallel raceways apart at least six times O.D. of raceway used.
4. Restrict O.D. of raceway in solid slabs to 1/4 of slab thickness with raceway placed in middle of that thickness.

5. Do not use raceway coating, except galvanizing or equivalent coating.
 6. Do not cut or displace any reinforcement.
- D. Install raceways to avoid damage or penetration of structural members. Avoid horizontal or cross runs in building partitions or sidewalls.
- E. For raceway larger than 2 inches, provide minimum 2 inches between raceways vertically penetrating elevated concrete slabs. Provide fire-stopping and spray-on fireproofing at locations where raceways penetrate surface of floor slab that is part of fire rating required for construction.
- F. Change from ENT to GRC before rising above floor. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- G. Exposed Raceways
1. Use exposed raceway on exterior surfaces and interior finished spaces only when raceway type and routing are approved by Architect and Owner's representative.
 2. Install exposed raceway in unfinished spaces, crawl spaces, pipe spaces, or in areas with existing exposed raceway. In areas where walls/ceilings are to be painted, exposed raceways shall be painted to match.
 3. Install exposed raceways and extensions from concealed raceway systems neatly, parallel with, or at right angles to walls of building.
 4. Do not run raceway through walls with plaster finish or through masonry walls or floors. Install pipe sleeves for raceway runs through these areas.
 5. Install exposed raceway to avoid interfering with ceiling inserts, lights or ventilation ducts or outlets.
 6. Support exposed raceways using hangers, clamps or clips. Support raceways on each side of bends and space not more than 6 ft. O.C. for 1-inch raceway and not more than 8 ft. O.C. for 1-1/4-inch raceway.
 7. Provide exposed raceways for outlets on waterproof walls and set anchors supporting raceway in waterproof cement.
 8. Support multiple raceway runs on trapeze style assemblies. Do not support raceway or cable from pipe, ductwork, or other raceway systems.
 9. Apply exposed raceways requirements specified above to raceways installed in space above hung ceilings and in crawl spaces.
 10. Do not install raceway directly on floors.
- H. Raceways for Optical Fiber Communications Cable
1. Raceways for Optical Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical fiber/communications cable raceway.

2. Raceways for Concealed General Purpose Distribution of Optical Fiber or Communications Cable: Plenum-type, optical fiber/communications cable raceway
 3. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, in damp or wet locations.
- I. Minimum Raceway Size: 1/2-inch (16-mm)
- J. Surface Raceways: Use surface raceways in finished spaces to conceal new cabling that cannot be installed above accessible ceiling or within walls. Use surface raceway only when raceway type and routing are approved by Architect and Owner's representative. Securely support from building construction and secure to masonry surfaces with expansion anchors. Mount at heights at locations shown on Drawings; obtain approval from Architect and Owner's representative for all routing not indicated on Drawings. Do not run surface raceway through walls with plaster finish or through masonry walls or floors. Install pipe sleeve with junction boxes or adapter fittings for raceway runs through these areas. In existing construction, run raceway along top of baseboards, taking care to avoid telephone and other signal wiring around doorframes and other openings. Run raceway on ceiling or walls perpendicular to or parallel with walls and floors.
- K. Raceways for Future Use (Spare Raceways and Empty Raceways): Draw fish tape through raceways to confirm that raceway is clear of obstructions. Leave pulling-in line in each spare and empty raceway.
- L. Raceway Installation in Special Areas
1. Raceways Exposed to Different Temperatures: Where portions of interior raceway system are exposed to widely different temperatures, seal interior and exterior of raceway to prevent circulation of air from warmer to colder section through raceway installation.
 2. Refrigerated Rooms: Install raceway body or junction box in raceway system on warm side of refrigerated room. After cables are installed, seal raceway interior at raceway body or junction box.
 3. Heated Areas to Unheated Areas: After cables are installed, seal raceway interior at nearest raceway body, outlet or junction box in heated area adjoining unheated area.
- M. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Provide locknuts for securing raceway to metal enclosure with sharp edge for digging into metal and ridged outside circumference for proper fastening.
 2. Provide bushings for terminating raceways smaller than 1-1/4 inches with flared bottom and ribbed sides with smooth upper edges to prevent injury to cable insulation.
 3. Install insulated type bushings for terminating raceways 1-1/4 inches and larger with flared bottom and ribbed sides and with upper edge with phenolic insulating ring molded into bushing.
 4. Provide screw-type grounding terminal for standard or insulated type bushing.

5. Provide miscellaneous fittings such as reducers, chase nipples, 3-piece unions, split couplings and plugs specifically designed for their particular application.

N. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C) and that has straight-run length that exceeds 25 feet (7.6 m). Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F (55 deg C) and that has straight-run length that exceeds 100 feet (30 m).
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

O. Fittings and Accessories Installation

1. Use zinc electroplate or hot dipped galvanized steel fittings and accessories in conjunction with ferrous raceways in dry and damp locations.
2. Use hot dipped galvanized fittings and accessories in conjunction with ferrous raceways in wet locations.
3. Use caps or plugs to seal ends of raceways until cable is installed (to exclude foreign material).
4. Use deflection fittings where raceways cross expansion joints that move in more than one plane.

5. Use 2 locknuts and insulated bushing (plastic bushing on 1/2-inch raceway and 3/4-inch raceway) on end of each raceway entering sheet metal cabinet or box in dry or damp locations. Terminate raceway ends within cabinet/box at same level.
6. Use watertight hub on end of each raceway entering cabinets or boxes (in wet locations) not constructed with integral threaded hubs.
7. Specific Applications:
 - a. Galvanized Rigid Conduit: Use threaded fittings and accessories. Use 3-piece raceway coupling where raceway cannot be rotated.
 - b. Flexible Metal Raceway: Use flexible metal raceway connectors.
 - c. Liquid Tight Flexible Metal Raceway: Use “seal-tite” connectors.
8. Rigid Nonmetallic Raceway, Metal Surface Raceway, and Wireways: Use manufacturer's standard fittings and accessories.

3.2 EXISTING RACEWAYS

A. Conditions for Re-Use of Existing Raceways:

1. Existing raceway is adequately sized for new cables.
2. Remove existing cables.
3. Demonstrate to Architect that existing raceway is clear of obstructions and in good condition.
4. Install insulated bushings to replace damaged or missing bushings. Replace non-insulated bushings with insulated bushings on raceway sizes 1 inch and larger.

3.3 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on drawings or in this article are stricter.

B. Raceways for Optical Fiber and Communications Cable: Install raceways, metallic and nonmetallic, rigid and flexible, as follows:

1. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

3.4 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 26 05 33

SECTION 26 05 43 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Direct buried conduit, ducts, and duct accessories.
 - 2. Concrete encased conduit, ducts, and duct accessories.
 - 3. Handholes and pull boxes.

1.3 DEFINITION

- A. RMC: Rigid metallic conduit.
- B. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS, GENERAL

- A. General: Submit all action submittals and informational submittals required by this Section concurrently.

1.5 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Duct-bank materials, including separators and miscellaneous components.
 - 2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
 - 3. Accessories for handholes, pull boxes, and other utility structures.
 - 4. Warning tape.
- B. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:
 - 1. Duct entry provisions, including locations and duct sizes.
 - 2. Reinforcement details.
 - 3. Step details.

4. Grounding details.
5. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
6. Joint details.

1.6 QUALITY ASSURANCE

- A. Comply with IEEE C2.
- B. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.
- B. Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.
- C. Lift and support precast concrete units only at designated lifting or supporting points.

1.8 PROJECT CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 1. Notify Owner no fewer than two days in advance of proposed interruption of electrical service.
 2. Do not proceed with interruption of electrical service without Owner's written permission.
- B. Ground Water: Assume ground-water level is 36 inches below ground surface unless a higher water table is noted on Drawings.

1.9 COORDINATION

- A. Coordinate layout and installation of conduits, ducts, handholes, and pull boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.
- B. Coordinate elevations of conduits, ducts and duct-bank entrances into handholes, and pull boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that conduit and duct runs drain to handholes, and as approved by Architect.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR DUCTS AND RACEWAYS

- A. Comply with ANSI C2.

2.2 CONDUIT

- A. Rigid Metallic Conduit (RMC): Galvanized. Comply with ANSI C80.1.
- B. Rigid Non-metallic Conduit (RNC): NEMA TC 2, Type EPC-40-PVC and Type EPC-80-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.
- C. Solvents and Adhesives: Same manufacturer as conduit manufacturer.

2.3 NONMETALLIC DUCTS AND DUCT ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. AFC Cable Systems. (verify)
 - 2. ARNCO Corporation.
 - 3. Beck Manufacturing.
 - 4. Cantex, Inc.
 - 5. CertainTeed Corp.
 - 6. Condux International, Inc.
 - 7. DCX-CHOL Enterprises, Inc.; ELECSYS Division. (verify)
 - 8. Electri-Flex Company.
 - 9. IPEX Inc.
 - 10. Lamson & Sessions; Carlon Electrical Products.
 - 11. Manhattan/CDT; a division of Cable Design Technologies.
- B. Duct Accessories:
 - 1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and retained to provide minimum duct spacing indicated while supporting ducts during concreting or backfilling.
 - 2. Warning Tape: Underground-line warning tape specified in Division 26 Section "Identification for Electrical Systems."

2.4 PRECAST CONCRETE HANDHOLES AND PULL BOXES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Christy Concrete Products.

2. Elmhurst-Chicago Stone Co.
 3. Oldcastle Precast Group.
 4. Riverton Concrete Products; a division of Cretex Companies, Inc.
 5. Utility Concrete Products, LLC.
 6. Wausau Tile Inc.
- B. Comply with ASTM C 858 for design and manufacturing processes.
- C. Ferrous metal hardware shall be hot-dip galvanized in accordance with ASTM A153 and ASTM A123.
- D. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or pull box.
1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing stainless-steel bolts.
 2. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 3. Cover Legend: Molded lettering, As indicated for each service.
 4. Configuration: Units shall be designed for flush burial and have (type?) bottom unless otherwise indicated.
 5. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
 - a. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.
 6. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.
 7. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
 - a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
 - b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
 - c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
 8. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
 - a. Type and size shall match fittings to duct or conduit to be terminated.

- b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.
- 9. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.5 HANDHOLES AND PULL BOXES OTHER THAN PRECAST CONCRETE

A. Description: Comply with SCTE 77.

- 1. Color: Gray or Green to suit location.
- 2. Configuration: Units shall be designed for flush burial and have closed bottom unless otherwise indicated.
- 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
- 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
- 5. Cover Legend: Molded lettering.
 - a. As indicated for each service.
 - b. Tier level number, indicating that the unit complies with the structural load test for that tier according to SCTE 77.
- 6. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, retained to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
- 7. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
- 8. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

B. Polymer Concrete Handholes and Pull Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two. Handholes and pull boxes shall comply with the requirements of SCTE 7 Tier 15 loading.

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Armorcast Products Company.
 - b. Carson Industries LLC.
 - c. CDR Systems Corporation.
 - d. Hubbell Power Systems;
 - e. NewBasis.

2.6 UTILITY STRUCTURE ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Bilco Company (The).
 2. Campbell Foundry Company.
 3. Christy Concrete Products.
 4. East Jordan Iron Works.
 5. Elmhurst-Chicago Stone Co.
 6. Hubbell Power Systems; Lenoir City Division. (verify)
 7. McKinley Iron Works.
 8. Neenah Foundry Company.
 9. NewBasis.
 10. Oldcastle Precast Group.
 11. Osburn Associates, Inc.
 12. Pennsylvania Insert Corporation.
 13. Riverton Concrete Products; a division of Cretex Companies, Inc.
 14. Underground Devices, Inc.
 15. Utility Concrete Products, LLC.
 16. Wausau Tile Inc.
- B. Ferrous metal hardware, where indicated, shall be hot-dip galvanized complying with ASTM A 153 and A 123.
- C. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch-diameter eye, and 1-by-4-inch bolt.
1. Working Load Embedded in 6-Inch, 4000-psi Concrete: 13,000-lbf minimum tension.
- D. Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1-1/4-inch-diameter eye, rated 2500-lbf minimum tension.
- E. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch-diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.
1. Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension.
- F. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch ID by 2-3/4 inches deep, flared to 1-1/4 inches minimum at base.
1. Tested Ultimate Pullout Strength: 12,000 lbf minimum.
- G. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch bolt, 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.

- H. Cable Rack Assembly: Steel, hot-dip galvanized, except insulators.
 - 1. Stanchions: T-section or channel; 2-1/4-inch nominal size; punched with 14 holes on 1-1/2-inch centers for cable-arm attachment.
 - 2. Arms: 1-1/2 inches wide, lengths ranging from 3 inches with 450-lb minimum capacity to 18 inches with 250-lb minimum capacity. Arms shall have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions.
 - 3. Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.
- I. Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, fiberglass-reinforced polymer.
 - 1. Stanchions: Nominal 36 inches high by 4 inches wide, with minimum of 9 holes for arm attachment.
 - 2. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in lengths ranging from 3 inches with 450-lb minimum capacity to 20 inches with 250-lb minimum capacity. Top of arm shall be nominally 4 inches wide, and arm shall have slots along full length for cable ties.
- J. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F. Capable of withstanding temperature of 300 deg F without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate layout and installation of ducts, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.
- B. Coordinate elevations of ducts and duct-bank entrances into handholes, and boxes with final locations and profiles of ducts and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct runs drain to handholes, and as approved by Architect.

3.2 CORROSION PROTECTION

- A. Aluminum shall not be installed in contact with earth or concrete.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31 Section "Earth Moving" or as shown on drawing details for pipe less than 6 inches (150 mm) in nominal diameter.
2. Install backfill as specified in Division 31 Section "Earth Moving" or as shown on drawing details.
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving" or as shown on drawing details
4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
 - b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
5. Warning tape: Bury warning tape approximately 12 inches (300 mm) above direct-buried conduits.

3.4 UNDERGROUND DUCT APPLICATION

- A. Ducts for Electrical Cables over 600 V: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank unless otherwise indicated.
- B. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank unless otherwise indicated.
- C. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank unless otherwise indicated.
- D. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank unless otherwise indicated.
- E. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank unless otherwise indicated.
- F. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40-PVC installed in concrete-encased duct bank unless otherwise indicated.

- G. Underground Ducts for Telephone, Communications, or Data Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank unless otherwise indicated.
- H. Underground Ducts Crossing Paved Paths, Walks and Driveways Roadways and Railroads: RNC, NEMA Type EPC-40-PVC, encased in reinforced concrete 5 feet beyond crossing.

3.5 UNDERGROUND ENCLOSURE APPLICATION

- A. Handholes and Pull Boxes for 600 V and Less:
 - 1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17 structural load rating.
 - 2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17 structural load rating.
 - 3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Precast concrete, AASHTO HB 17 structural load rating.
 - 4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf "Light-Duty" vertical loading.

3.6 EARTHWORK

- A. Excavation and Backfill: Comply with Division 31 Section "Earth Moving" but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restore surface features at areas disturbed by excavation and reestablish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32 Sections "Turf and Grasses" and "Plants."
- D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 32 Paving Section(s).

3.7 DUCT INSTALLATION

- A. Slope: Pitch ducts a minimum slope of 1:300 down toward handholes and away from buildings and equipment.
- B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches both horizontally and vertically, at other locations unless otherwise indicated.

- C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.
- D. Duct Entrances to Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch ducts, and vary proportionately for other duct sizes.
 - 1. Begin change from regular spacing to end-bell spacing 10 ft. from the end bell without reducing duct line slope and without forming a trap in the line.
 - 2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to handhole.
 - 3. Grout end bells into structure walls from both sides to provide watertight entrances.
- E. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 ft. outside the building wall without reducing duct line slope away from the building and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition.
- F. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.
- G. Pulling Cord: Install 100-lbf- test nylon cord in ducts, including spares.
- H. Concrete-Encased Ducts: Support ducts on duct separators.
 - 1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 ft. of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
 - 2. Concreting Sequence: Pour each run of envelope between other terminations in one continuous operation.
 - a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
 - b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18 inches into concrete on both sides of joint near corners of envelope.
 - 3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.

4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
6. Minimum Space between Ducts. As shown on details on Drawings..
7. Depth: As shown on details on Drawings..
8. Manufactured PVC duct elbows in first subparagraph below are vulnerable to damage by pulling lines when cable pulling tensions are high. However, concrete encasement, together with reduced pulling tensions, can prevent serious damage. Reduce potential pulling tensions by making duct runs from the closest handhole as short as possible and arranging stub-up elbows to have the longest possible radius. 5-inch (125-mm) duct is available in standard radii of 24, 36, 48, and 60 inches (300, 900, 1200, and 1500 mm) and greater. If necessary, specify that stub-ups be made with rigid steel conduit elbows as provided in second subparagraph below.
9. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
 - b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.
10. Warning Tape: Bury warning tape above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches of the centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

I. Direct-Buried Duct Banks:

1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
2. Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 ft. of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches between tiers.
3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Division 31 Section "Earth Moving" for pipes less than 6 inches in nominal diameter.
4. Install backfill as specified in Division 31 Section "Earth Moving."

5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4 inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."
6. Install ducts with a minimum of 3 inches between ducts for like services and 12 inches between power and signal ducts.
7. Depth: Install top of duct bank at least 36 inches below finished grade unless otherwise indicated.
8. Set elevation of bottom of duct bank below the frost line.
9. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
10. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
 - b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

3.8 INSTALLATION OF CONCRETE HANDHOLES AND PULL BOXES

A. Precast Concrete Handhole Installation:

1. Comply with ASTM C 891 unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

B. Elevations:

1. Install handholes with bottom below the frost line,
2. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.
3. Where indicated, cast handhole cover frame integrally with handhole structure.

- C. Dampproofing: Apply dampproofing to exterior surfaces of handholes after concrete has cured at least three days. Dampproofing materials and installation are specified in Division 07 Section "Bituminous Dampproofing." After ducts have been connected and grouted, and before backfilling, dampproof joints and connections and touch up abrasions and scars.
- D. Hardware: Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.
- E. Field-Installed Bolting Anchors in Concrete Handholes: Do not drill deeper than 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

3.9 INSTALLATION OF HANDHOLES AND PULL BOXES OTHER THAN PRECAST CONCRETE

- A. Install handholes and pull boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use pull box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.
- B. Unless otherwise indicated, support units on a level 6-inch- thick bed of crushed stone or gravel, graded from 1/2-inch sieve to No.4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: Set so cover surface will be flush with finished grade.
- D. Install handholes and pull boxes with bottom below the frost line below grade or as indicated on details on Drawings.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Retain arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.
- F. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.10 GROUNDING

- A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.11 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
 - 2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
- B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.12 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

END OF SECTION 26 05 43

SECTION 26 05 44 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Sleeves for raceway and cable penetration of walls and floors.
 - 2. Sleeve-seal systems.
 - 3. Sleeve-seal fittings.
 - 4. Grout.
 - 5. Silicone sealants.

- B. Related Requirements:

- 1. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 "Penetration Firestopping".

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Wall Sleeves:

- 1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
 - 2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

- C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

- D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

E. Sleeves for Rectangular Openings:

1. Material: Galvanized sheet steel.
2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
 - b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. Advance Products & Systems, Inc.
 - b. CALPICO, Inc.
 - c. Metraflex Company (The).
 - d. Pipeline Seal and Insulator, Inc.
 - e. Proco Products, Inc.
2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of raceway. Include type and number required for raceway material and size of raceway.
3. Pressure Plates: Carbon steel.
4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.4 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
 - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
 - 2. Sealant shall have VOC content of 40 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 3. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
 - 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 - 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level. Install sleeves during erection of floors.

- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between raceway and sleeve for installing mechanical sleeve seals.
- G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

3.4 SLEEVE INSTALLATION FOR FIRE RATED ASSEMBLY PARTITIONS

- A. Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- B. Maintain indicated fire rating of walls, partitions, ceilings and floors at raceway penetrations. Install sleeves and sleeve seals with appropriate firestop materials. Comply with Division 07 Section "Penetration Firestopping".

END OF SECTION 26 05 44

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Identification for raceways.
 - 2. Identification of power and control cables.
 - 3. Identification for conductors.
 - 4. Underground-line warning tape.
 - 5. Warning labels and signs.
 - 6. Instruction signs.
 - 7. Equipment identification labels.
 - 8. Miscellaneous identification products.
- B. Provide identification on all equipment, raceways, boxes, conductors, and devices.
- C. Identification provided should match the identification names, designations, and letters/numbers indicated on drawings, schematic and interconnection diagrams, equipment manufacturer's shop drawings, and in specifications.

1.3 QUALITY ASSURANCE

- A. Comply with ANSI A13.1.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.4 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 POWER RACEWAY IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.
- B. Colors for Raceways Carrying Circuits at 600 V or Less:
 - 1. Black letters on an orange field.
 - 2. Legend: Indicate voltage and system or service type.
- C. Colors for Raceways Carrying Circuits at More Than 600 V:
 - 1. Black letters on an orange field.
 - 2. Legend: "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch- (75-mm) high letters on 20-inch (500-mm) centers.
- D. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- E. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- F. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- G. Tape and Stencil for Raceways Carrying Circuits More Than 600 V: 4-inch- (100-mm-) wide black stripes on 10-inch (250-mm) centers diagonally over orange background that extends full length of raceway or duct and is 12 inches (300 mm) wide. Stop stripes at legends.
- H. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking cable tie fastener.
- I. Write-On Tags: Polyester tag, 0.015 inch (0.38 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.2 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- D. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- E. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- F. Write-On Tags: Polyester tag, 0.015 inch (0.38 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.3 FLOOR MARKING TAPE

- A. 2-inch- (50-mm-) wide, 5-mil (0.125-mm) pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.4 UNDERGROUND-LINE WARNING TAPE

- A. Tape:
 - 1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
 - 2. Printing on tape shall be permanent and shall not be damaged by burial operations.
 - 3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.
 - 4. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
 - 5. Overall Thickness: 5 mils (0.125 mm).

6. Foil Core Thickness: 0.35 mil (0.00889 mm).
7. Weight: 28 lb/1000 sq. ft. (13.7 kg/100 sq. m).
8. 3-Inch (75-mm) Tensile According to ASTM D 882: 70 lbf (311.3 N), and 4600 psi (31.7 MPa).

B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

2.5 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Baked-Enamel Warning Signs:

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch (6.4-mm) grommets in corners for mounting.
3. Nominal size, 7 by 10 inches (180 by 250 mm).

D. Metal-Backed, Butyrate Warning Signs:

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application.
2. 1/4-inch (6.4-mm) grommets in corners for mounting.
3. Nominal size, 10 by 14 inches (250 by 360 mm).

E. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."

2.6 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. inches (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.
 - 1. Engraved legend with black letters on white face.
 - 2. Punched or drilled for mechanical fasteners.
 - 3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.
- B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.

2.7 EQUIPMENT IDENTIFICATION LABELS

- A. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).
- B. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).
- C. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch (25 mm) .

2.8 CABLE TIES

- A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.
 - 1. Minimum Width: 3/16 inch (5 mm).
 - 2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
 - 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
 - 4. Color: Black except where used for color-coding.
- B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.
 - 1. Minimum Width: 3/16 inch (5 mm).
 - 2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
 - 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
 - 4. Color: Black.
- C. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.
 - 1. Minimum Width: 3/16 inch (5 mm).
 - 2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 7000 psi (48.2 MPa).

3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).
5. Color: Black.

2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- F. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.
- G. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.
- H. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
 1. Outdoors: UV-stabilized nylon.
 2. In Spaces Handling Environmental Air: Plenum rated.
- I. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches (400 mm) overall.

- J. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

- A. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil 4-inch- (100-mm-) wide black stripes on 10-inch (250-mm) centers over orange background that extends full length of raceway or duct and is 12 inches (300 mm) wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch- (75-mm-) high black letters on 20-inch (500-mm) centers. Stop stripes at legends. Apply to the following finished surfaces:
1. Floor surface directly above conduits running beneath and within 12 inches (300 mm) of a floor that is in contact with earth or is framed above unexcavated space.
 2. Wall surfaces directly external to raceways concealed within wall.
 3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.
- B. Accessible Raceways, More Than 600 V: Self-adhesive vinyl labels. Install labels at 10-foot (3-m) maximum intervals.
- C. Accessible Raceways and Cables within Buildings: Identify raceways and the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
1. Emergency Power.
 2. Exit lights
 3. Power.
- D. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service feeder and branch-circuit conductors.
 - a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
 - b. Colors for 208/120-V Circuits:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - c. Colors for 480/277-V Circuits:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.

- d. **Field-Applied, Color-Coding Conductor Tape:** Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- E. **Power-Circuit Conductor Identification, More than 600 V:** For conductors in vaults, pull and junction boxes, manholes, and handholes, use write-on tags.
- F. **Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.**
- G. **Conductors to Be Extended in the Future:** Attach write-on tags to conductors and list source.
- H. **Auxiliary Electrical Systems Conductor Identification:** Identify field-installed alarm, control, and signal connections.
 - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 - 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 - 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
- I. **Locations of Underground Lines:** Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
 - 1. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- J. **Workspace Indication:** Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- K. **Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting:** Self-adhesive warning labels:
 - 1. Comply with 29 CFR 1910.145.
 - 2. Identify system voltage with black letters on an orange background.
 - 3. Apply to exterior of door, cover, or other access.
 - 4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
 - a. Power transfer switches.
 - b. Controls with external control power connections.

- L. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
- M. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer.
- N. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own, user readable identification.

1. Labeling Instructions:

- a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.
- b. Outdoor Equipment: Engraved, laminated acrylic or melamine label, Stenciled legend 4 inches (100 mm) high.
- c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
- d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

2. Equipment to Be Labeled:

- a. Power, Lighting, and Control:
 - 1) Switchboards, Panelboards, MCCs, Equipment Cabinets, Control Panels, Generators, UPS Equipment, Battery Inverter Units, Disconnect Switches, Enclosed Circuit Breakers, and Motor Controllers:
 - a) Typewritten panelboard directory of circuits in the location provided by panelboard manufacturer.
 - b) Provide nameplate with equipment identification as indicated on the drawings.
 - c) Indicate source and location of the source.
 - d) Provide nominal system voltage designation labels on cover.
 - 2) Disconnect Switches and Enclosed Circuit Breakers:
 - a) Indicate the equipment designation and location which the disconnect serves.

- 3) Motor Controllers and VFD's:
 - a) Indicate the motor designation, location, and the type of service.
- b. Transfer Switches:
 - 1) Provide nameplate with equipment identification as indicated on the drawings.
 - 2) Indicate the equipment designation and location which the transfer switch serves.
 - 3) Indicate normal and standby/emergency sources and location of the sources.
 - 4) Provide nominal system voltage designation labels on cover.
- c. Pull boxes, Enclosures, Junction Boxes:
 - 1) Provide identification labels with feeder, branch circuit, and control circuit numbers on cover.
 - 2) Indicate source(s) and location(s) of the source(s).
 - 3) Indicate the load(s) and location(s) of the load(s) served.
 - 4) Provide nominal system voltage designation labels on cover.
- d. Feeder Circuits, Branch Circuits, Control Circuits, Site Lighting Circuits:
 - 1) Provide cable tags, wire markers, and phase identification tape as appropriate.
 - 2) Identify circuits in each junction box, pull box, outlet box, enclosure, gutter, manhole, handhole, lighting standard base, and at each termination.
 - 3) Identify with circuit number, load and location served, and panel (equipment) designation and location from which it originates.
 - 4) Include identification of the building from which it originates for exterior circuits.
- e. Circuits Over 600 Volts:
 - 1) Cables should be identified at each manhole, handhole, junction box, transformer, switch, and at each termination using cable tags.
 - 2) Identify nominal voltage, circuit number, circuit size, load served, and equipment designation and location from which it originates.
 - 3) Exposed conduit runs should be identified continuously similar to "DANGER – 4160 VOLTS", "DANGER – 13,200 VOLTS" or as appropriate.
- f. Underground Conduits and Circuits:
 - 1) Provide warning ribbon above the underground installation. The ribbon should be capable of being identified by a metal detector. The ribbon shall include continuous lettering similar to "CAUTION BURIED ELECTRIC BELOW".

- g. Empty Conduit Runs and Conduits with Conductors for Future Use:
 - 1) Provide cable tags
 - 2) Indicate proposed future use
 - 3) Label conduits and conductors at both ends, including location of another end.
 - h. Receptacles, Switches, and Control Devices:
 - 1) Provide identification label on faceplate.
 - 2) Identify branch circuit number and panel designation and location from which it originates.
 - 3) Identify receptacles supplied from GFCI-type circuit breakers as “GFCI Protected”.
 - i. Emergency Lighting Fixtures:
 - 1) Provide identification labels on ceiling mounted emergency light fixtures, which have integral battery ballast backup or are tied into an emergency power system (i.e. emergency generator, central battery inverter, etc.). Labels should be attached to these fixtures so that they are readily discernible, by a person standing on the normal walking surface in the area, for testing purposes.
3. Normal and Emergency Systems:
- a. Equipment Cabinets, Terminal Cabinets, Control Panels, Patch Panels, Racks:
 - 1) Provide nameplates with equipment identification as indicated on the drawings.
 - 2) Label termination blocks and ports.
 - 3) Provide nominal system voltage designation labels on cover
 - b. Pull boxes, Enclosures, Junction Boxes:
 - 1) Provide identification labels including system type and circuit numbers on cover.
 - 2) Indicate equipment and location(s) from which enclosed cables originate.
 - 3) Indicate the equipment and location(s) of the equipment served.
 - 4) Provide nominal system voltage designation labels on cover.
 - c. Cables and Conduits:
 - 1) Provide cable tags, wire markers, and identification labels including system type and circuit numbers as appropriate.
 - 2) Identify cables in each junction box, pull box, device box, enclosure, gutter, manhole, handhole, and at each termination.
 - 3) Identify with cable number, equipment and location(s) of the equipment served, and equipment designation and location from which it originates.
 - 4) Label conduits at both ends, including conduit number and location of other end.

- 5) Include identification of the building from which it originates for exterior cables.
- d. Underground Conduits and Cables:
- 1) Provide warning ribbon above the underground installation. The ribbon shall be capable of being identified by a metal detector. The ribbon shall include continuous lettering similar to “CAUTION BURIED ELECTRIC BELOW”.
- e. Empty Conduit Runs and Conduits with Cables for Future Use:
- 1) Provide cable tags and identification labels.
 - 2) Indicate proposed future use.
 - 3) Label conduits and cables at both ends (including location of other end).
- f. Fire Alarm:
- 1) Fire alarm junction boxes and pull fittings should be painted red to identify them as components of the fire alarm system as compared to other systems.
 - 2) Remote Smoke Detector Lamps and Test Stations – Provide nameplate indicating the location of the connected device.
 - 3) Initiation Devices, Notification Appliances, Fire Alarm Relays – Provide device identification and zone or address identification label.
 - 4) Communication:
 - a) Comply with applicable EIA, TIA, and ANSI standards.
 - b) Data Outlets – Provide device identification label on faceplate. Identify equipment designation and location from which it originates.
 - 5) Security:
 - a) Provide device identification labels.
 - b) Identify equipment designation and location from which it originates.
- g. Access doors and panels for concealed electrical items.
- h. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.

END OF SECTION 26 05 53

SECTION 26 08 00 - COMMISSIONING OF ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and other Division 01 Specification Sections, apply to this Section.
 - 1. See especially Section 01 08 00, "General Commissioning Requirements" for general commissioning process requirements and Commissioning Coordinator responsibilities.

1.2 SUMMARY

- A. Section includes commissioning process requirements for Lighting Control Systems, which are described in more detail in the technical specification 26 09 23 Lighting Control Devices.

1.3 DEFINITIONS

- A. CxA: Commissioning Authority.

1.4 SUBMITTALS

- A. Submittals shall comply with the requirements of the Construction Contract Clauses, Section 01 33 00 "Submittal Procedures" and the individual sections specifying the work.
- B. Prefunctional Checklists of readiness.
- C. Prefunctional Checklists of completion of installation, prestart, and startup activities.
- D. Certificates of readiness and completion of installation.
- E. Test and inspection reports and certificates.
- F. Corrective action documents.
- G. Functional Performance Test Procedures

1.5 QUALITY ASSURANCE

- A. Lighting Control Testing Technician Qualifications: Technicians to perform Lighting Control Construction Prefunctional Checklist verification tests and demonstrations, functional performance tests and demonstrations shall have the following minimum qualifications:
 - 1. Journey-level or equivalent skill level in Electrical Testing or Installation. Vocational School four-year program graduate or an Associate's degree in electrical systems, or similar field. Degree may be offset by three years' experience in servicing electrical systems in the HVAC or Electrical industry.

1.6 CONTRACTOR'S RESPONSIBILITIES

- A. Provide Electrical work in accordance with contract document requirements for Lighting Control Systems.
- B. Perform commissioning tests at the direction of the CxA.
- C. Attend construction phase coordination meetings.
- D. Attend testing, adjusting, and balancing review and coordination meeting.
- E. Participate in Lighting Control systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.
- F. Provide information requested by the CxA for final commissioning documentation.
- G. Provide measuring instruments and logging devices to record test data and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.7 CxA'S AUTHORITY

- A. Provide Project-specific construction checklists and commissioning process test procedures for actual Lighting Control systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.
- B. Directing commissioning.
- C. Verify testing, adjusting, and balancing of Work are complete.
- D. Provide test data, inspection reports, and certificates in Systems Manual.

1.8 COMMISSIONING DOCUMENTATION

- A. Provide the following information to the CxA for inclusion in the commissioning plan:
 - 1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
 - 2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
 - 3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for Lighting Control system to be verified and tested.
 - 4. Prefunctional Checklists certifying that installation, prestart checks, and startup procedures have been completed.
 - 5. Prefunctional Checklists certifying that Lighting Control systems, subsystems, equipment, and associated controls are ready for testing.
 - 6. Test and inspection reports and certificates.
 - 7. Corrective action documents.
 - 8. Verification of testing and adjusting reports.

PART 2 - EXECUTION

2.1 TESTING PREPARATION

- A. Certify that Lighting Control systems have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

2.2 GENERAL TESTING REQUIREMENTS

- A. The CxA in cooperation with the Electrical Contractor shall prepare detailed testing plans, procedures, and checklists for Lighting control systems.

2.3 LIGHTING CONTROL SYSTEMS FUNCTIONAL TESTING PROCEDURES

- A. Lighting Control System Functional Testing and Acceptance Procedures:
 - 1. Occupancy Sensor Controls:
 - a. Certify that the occupant sensor has been located and aimed in accordance with manufacturer recommendations.
 - b. Each occupancy sensor shall be tested, where applicable.
 - 1) Verify the correct operation of occupant sensor controls status indicators.
 - 2) Verify the controlled lights turn off or down to the permitted level within the required time.
 - 3) Verify the lights turn on to the permitted level when an occupant enters the space for auto-on occupant sensor controls.
 - 4) Verify the lights turn on only when manually activated for manual-on occupancy sensors.
 - 5) Verify the lights are not incorrectly turned on by movement in adjacent areas or by HVAC operation.
 - 2. Daylight Responsive Controls
 - a. Verify control devices have been properly located, field calibrated and set for accurate setpoints and threshold light levels.
 - b. Verify daylight controlled lighting loads adjust to light level set points in response to available daylight.
 - c. Verify the locations of calibration adjustment equipment are readily accessible to authorized personal.
 - 3. Photocells and BMS Scheduled Control – Site Lighting
 - a. Verify control devices have been properly located, field calibrated and set for accurate setpoints and threshold light levels.

- b. Verify photocell adjust to light level set points in response to available daylight.
 - c. Verify the locations of calibration adjustment equipment are readily accessible to authorized personal.
- B. Provide documentation and certification to the CxA.
- C. Lighting Control systems are shown on the contract drawings.

END OF SECTION 26 08 00

SECTION 26 09 23 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Daylight-harvesting dimming controls, digital.
2. Indoor occupancy and vacancy sensors.
3. Touch Screen Stations.
4. Low Voltage Controls.
5. Conductors and cables.

B. Related Requirements:

1. Section 262726 "Wiring Devices" for wall-box dimmers, non-networkable wall-switch occupancy sensors, and manual light switches.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Daylight-harvesting dimming controls, digital.
2. Indoor occupancy and vacancy sensors.
3. Touch Screen Stations.
4. Low Voltage Controls.
5. Conductors and cables.

B. Shop Drawings:

1. Show installation details for the following:
 - a. Occupancy sensors.
 - b. Vacancy sensors.
 - c. Daylight-harvesting dimming controls, digital.
 - d. Touch Screen Stations.
 - e. Low Voltage Control
2. Interconnection diagrams showing field-installed wiring.
3. Include diagrams for power, signal, and control wiring.

C. Field quality-control reports.

1.3 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For manufacturer's warranties.

1.4 WARRANTY

- A. Special Extended Warranty: Manufacturer and Installer warrant that installed lighting control devices perform in accordance with specified requirements and agree to repair or replace, including labor, materials, and equipment, devices that fail to perform as specified within extended warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Faulty operation of lighting control devices.

PART 2 - PRODUCTS

2.1 DAYLIGHT-HARVESTING DIMMING CONTROLS, DIGITAL

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Casambi
 - 2. Leviton.
 - 3. Steinel.
- B. Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, lights are dimmed.
 - 1. Lighting control set point is based on the following two lighting conditions:
 - a. When no daylight is present (target level).
 - b. When significant daylight is present.
 - 2. System programming is done with two hand-held, remote-control tools.
 - a. Initial setup tool.
 - b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.
- C. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with **integrated** power pack to detect changes in indoor lighting levels that are perceived by the eye.
- D. Electrical Components, Devices, and Accessories:
 - 1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
 - 2. Sensor Output: zero to 10 V(dc) to operate luminaires. Sensor is powered by controller unit.
 - 3. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc.

- E. Power Pack: Digital controller capable of accepting three 8PSJ inputs with **two** output(s) rated for 20 A LED load at 120 and 277 V(ac). Sensor has 24 V(dc) Class 2 power source.
1. With integral current monitoring.
 2. Compatible with digital addressable lighting interface.
 3. Plenum rated.

2.2 INDOOR OCCUPANCY AND VACANCY SENSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Casambi
2. Leviton.
3. Steinel.

- B. General Requirements for Sensors:

1. Ceiling mounted, solid-state indoor occupancy and vacancy sensors.
2. Dual technology.
3. Integrated power pack.
4. Hardwired connection to switch.
5. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
6. Operation:
 - a. Combination Sensor: Unless otherwise indicated, sensor must be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
7. Sensor Output: Sensor is powered from the power pack
8. Power: Line voltage
9. Power Pack: Dry contacts rated for 20 A LED load at 120 and 277 V(ac). Sensor has 24 V(dc), 150 mA, Class 2 power source.
10. Mounting:
 - a. Sensor: Suitable for mounting in any position in a standard device box or outlet box.
 - b. Relay: Externally mounted through a 1/2 inch knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

11. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
 12. Bypass Switch: Override the "on" function in case of sensor failure.
 13. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; turn lights off when selected lighting level is present.
- C. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
 2. Detector Sensitivity: Detect occurrences of 6 inch minimum movement of any portion of a human body that presents a target of not less than 36 sq. inch, and detect a person of average size and weight moving not less than 12 inch in either a horizontal or a vertical manner at an approximate speed of 12 inch/s.
 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96 inch high ceiling.
 4. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of 1000 sq. ft. when mounted 48 inch above finished floor.

2.3 TOUCH SCREEN STATIONS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. ETC.
 2. Crestron.
 3. Leviton.
- B. General Requirements:
1. Two-gang sized LCD switch station supports common Dialog Room Controller switching functions.
 2. Pre-programmed and configured for use with Dialog Room Controller systems.
 3. Kit includes 120Vac 60Hz to 24Vac transformer.
 4. Backlight switches OFF automatically after 10 seconds of inactivity.
- C. Technical Requirements:
1. Rated Voltage: 200mA 24Vac (from transformer).
 2. Signal Current: 15mA.
 3. Maximum distance between transformer and the farthest LCD switch: 300ft.
 4. Applicable Wires: Power 0.9mm.
 5. WR-4040-120.

6. 120Vac Primary.
7. 24Vac Secondary.
8. 40VA steady draw, 40VA pulsed draw.

2.4 LOW VOLTAGE CONTROL

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Douglas Controls.
 2. Leviton.
 3. ETC Echo.
- B. General Requirements:
 1. Modern Styling.
 2. LED Status Indication.
 3. Interchangeable keypads.
 4. 2-Wire Dialog for Data and Power.
 5. BT Programmable iOS App (free).
 6. Touchless Control via iOS Tap-to-Control App (free).
 7. •Available in multiple Colours.
 8. (White, Grey, Black, Ivory, Light Almond, Red).
 9. Custom Laser Etching (optional).
- C. Technical Requirements:
 1. 4-Button Programmable Dialog Dimmer Switch.
 2. Toggle, ON, OFF, Preset Activation, Raise, Lower, Timer.
 3. Target: Individual, Groups, Presets (Output, Mode Trigger, Behaviour Trigger).
 4. 2-Wire Dialog.
 5. LED Status indication.
 6. 4.12" x 1.75" x 0.75" (H x W x D) - Installs in standard gang wall boxes.
 7. Dialog Dataline (24VAC).
 8. Status, Standby Locator, Timer Expiration, Error.
 9. Indoor, stationary, non-vibrating, non-corrosive atmosphere, and non-condensing humidity.
 10. Operating temperature: 14°F to 140°F (-10°C to 60°C).
 11. Storage temperature: -14°F to 140°F (-25° to 60°C).
 12. ASHRAE 90.1 Compliant.
 13. FCC Compliant.

2.5 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.
- B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF SENSORS

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's instructions.

3.3 INSTALLATION OF WIRING

- A. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch.
- B. Wiring within Enclosures: Separate power-limited and nonpower-limited conductors in accordance with conductor manufacturer's instructions.
- C. Size conductors in accordance with lighting control device manufacturer's instructions unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, device, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

- A. Identify components and power and control wiring in accordance with Section 260553 "Identification for Electrical Systems."
 - 1. Identify controlled circuits in lighting contactors.
 - 2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

3.5 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Nonconforming Work:

1. Lighting control devices will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

C. Prepare test and inspection reports.

D. Manufacturer Services:

1. Engage factory-authorized service representative to support field tests and inspections.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION 26 09 23

SECTION 26 24 13 - SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Service and distribution switchboards rated 600 V and less.
 - 2. Disconnecting and overcurrent protective devices.
 - 3. Instrumentation.
 - 4. Control power.
 - 5. Accessory components and features.
 - 6. Identification.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of switchboard, overcurrent protective device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
- B. Shop Drawings: For each switchboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types for types other than NEMA 250, Type 1.
 - 3. Detail bus configuration, current, and voltage ratings.
 - 4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
 - 5. Detail utility company's metering provisions with indication of approval by utility company.
 - 6. Include evidence of NRTL listing for full interrupting rating of installed devices.
 - 7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

8. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device.
9. Include schematic and wiring diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Field Quality-Control Reports:
 1. Test procedures used.
 2. Test results that comply with requirements.
 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 1. Routine maintenance requirements for switchboards and all installed components.
 2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 3. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.
- B. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Comply with NEMA PB 2.

- F. Comply with NFPA 70.
- G. Comply with UL 891.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.
- B. Remove loose packing and flammable materials from inside switchboards and install temporary electric heating (250 W per section), to prevent condensation.
- C. Handle and prepare switchboards for installation according to NECA 400.

1.8 PROJECT CONDITIONS

- A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.
- B. Environmental Limitations:
 - 1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 104 deg F.
 - b. Altitude: Not exceeding 6600 feet.
- C. Service Conditions: NEMA PB 2, usual service conditions, as follows:
 - 1. Ambient temperatures within limits specified.
 - 2. Altitude not exceeding 6600 feet.
- D. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Owner no fewer than seven days in advance of proposed interruption of electric service.
 - 2. Indicate method of providing temporary electric service.
 - 3. Do not proceed with interruption of electric service without Owner's written permission.
 - 4. Comply with NFPA 70E.

1.9 COORDINATION

- A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Provide 5 inch concrete bases. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.10 WARRANTY

- A. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Front-Connected, Front-Accessible Switchboards:
 - 1. Main Devices: Panel mounted.
 - 2. Branch Devices: Panel mounted.
 - 3. Sections front and rear aligned.
- C. Front- and Side-Accessible Switchboards:
 - 1. Main Devices: Fixed, individually mounted.
 - 2. Branch Devices: Panel mounted.
 - 3. Sections front and rear aligned.
- D. Nominal System Voltage: 208Y/120 V.
- E. Main-Bus Continuous: 3000 A.
- F. Indoor Enclosures: Steel, NEMA 250, Type 1.
- G. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

- H. Utility Metering Compartment: Fabricated, barrier compartment and section complying with utility company's requirements; hinged sealed door; buses provisioned for mounting utility company's current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.
- I. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
- J. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
- K. Pull Box on Top of Switchboard:
 - 1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
 - 2. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.
 - 3. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
 - 4. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.
- L. Buses and Connections: Three phase, four wire unless otherwise indicated.
 - 1. Phase- and Neutral-Bus Material: Tin-plated, high-strength, electrical-grade aluminum alloy with tin-plated aluminum circuit-breaker line connections.
 - 2. Ground Bus: Minimum-size required by UL 891, hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors.
 - 3. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from distribution end.
 - 4. Disconnect Links:
 - a. Isolate neutral bus from incoming neutral conductors for switchboards utilized as service equipment.
 - b. Bond neutral bus to equipment-ground bus for switchboards utilized as service equipment or separately derived systems.
 - 5. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
- M. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.
- N. Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
 - 3. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - e. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
 - f. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
 - g. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
 - h. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
- B. Bolted-Pressure Contact Switch: Operating mechanism uses rotary-mechanical-bolting action to produce and maintain high clamping pressure on the switch blade after it engages the stationary contacts.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Boltswitch, Inc.
 - b. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - c. Pringle Electrical Manufacturing Company, Inc.

- d. Siemens Energy & Automation, Inc.
 - e. Square D; a brand of Schneider Electric.
- 2. Main-Contact Interrupting Capability: Minimum of 12 times the switch current rating.
- 3. Operating Mechanism: Manual handle operation to close switch; stores energy in mechanism for opening and closing.
 - a. Electrical Trip: Operation of lever or push-button trip switch, or trip signal from ground-fault relay or remote-control device, causes switch to open.
 - b. Mechanical Trip: Operation of mechanical lever, push button, or other device causes switch to open.
- 4. Service-Rated Switches: Labeled for use as service equipment.
- 5. Ground-Fault Relay: Comply with UL 1053; self-powered type with mechanical ground-fault indicator, test function, tripping relay with internal memory, and three-phase current transformer/sensor.
 - a. Configuration: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - b. Internal Memory: Integrates the cumulative value of intermittent arcing ground-fault currents and uses the effect to initiate tripping.
 - c. No-Trip Relay Test: Permits ground-fault simulation test without tripping switch.
 - d. Test Control: Simulates ground fault to test relay and switch (or relay only if "no-trip" mode is selected).

2.3 INSTRUMENTATION

- A. Instrument Transformers: IEEE C57.13, NEMA EI 21.1, and the following:
 - 1. Current Transformers: IEEE C57.13; 5 A, 60 Hz, secondary; bar or window type; single secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
- B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
 - 1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
 - a. Phase Currents, Each Phase: Plus or minus 1 percent.
 - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
 - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
 - d. Megawatts: Plus or minus 2 percent.
 - e. Megavars: Plus or minus 2 percent.
 - f. Power Factor: Plus or minus 2 percent.
 - g. Frequency: Plus or minus 0.5 percent.
 - h. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.

- i. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from five to 60 minutes.
 - j. Contact devices to operate remote Building Automation System impulse-totalizing demand meter.
- 2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

2.4 CONTROL POWER

- A. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.5 IDENTIFICATION

- A. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store switchboards according to NECA 400.
- B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.
- C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install switchboards and accessories according to NECA 400.
- B. Equipment Mounting: Install switchboards on concrete base, 5-inch nominal thickness. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to switchboards.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

- D. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
- E. Install filler plates in unused spaces of panel-mounted sections.
- F. Install overcurrent protective devices and instrumentation.
- G. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Instruments and Equipment:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Switchboard will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

3.6 PROTECTION

- A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

3.7 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories.

END OF SECTION 26 24 13

SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.
 - 3. Disconnecting and overcurrent protective devices.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of panelboard including switching and overcurrent protective device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
 - 3. Detail bus configuration, current, and voltage ratings.
 - 4. Short-circuit current rating of panelboards and overcurrent protective devices.
 - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 6. Include wiring diagrams for power, signal, and control wiring.
 - 7. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - 2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.
 - 3. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing
 - 4. Field test reports.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Keys: Two spares for each type of panelboard cabinet lock.
 - 2. Circuit Breakers Including GFCI Types: Two spares for each panelboard.

1.6 QUALITY ASSURANCE

- A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NEMA PB 1.
- E. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation according to NECA 407.

1.8 PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.
 - b. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet.

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Owner's written permission.
3. Comply with NFPA 70E.

1.9 COORDINATION

- ### A.
- Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Enclosures: Flush- and surface-mounted cabinets.

1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Outdoor Locations: NEMA 250, Type 3R.
 - c. Kitchen and Wash-Down Areas: NEMA 250, Type 4X, stainless steel.

- d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4 .
 - e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 5.
- 2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
- 3. Finishes:
 - a. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Surface mount, same finish as panels and trim. Flush mount, galvanized steel.
- 4. Directory Card: Inside panelboard door, mounted in transparent card holder.
- B. Incoming Mains Location: Top or bottom as required.
- C. Phase, Neutral, and Ground Buses:
 - 1. Material: Hard-drawn copper, 98 percent conductivity. Bus shall be fully rated the entire length.
 - 2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors
 - 3. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter
 - 4. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
 - 5. Extra-Capacity Neutral Bus: Where indicated, neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.
- D. Conductor Connectors: Suitable for use with conductor material and sizes.
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - 2. Main and Neutral Lugs: Mechanical type.
 - 3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
 - 4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 - 5. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
 - 6. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

- E. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- F. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 DISTRIBUTION PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Panelboards: NEMA PB 1, power and feeder distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
- D. Mains: Circuit breaker, fused switch, lugs only, as indicated on drawings.
- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
- F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
- G. Contactors in Main Bus: NEMA ICS 2, Class A, electrically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.
 - 1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: Circuit breaker or lugs only, as indicated on drawings.

- D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- E. Contactors in Main Bus: NEMA ICS 2, Class A, electrically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.
 - 1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
- F. Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; keyed alike. Outer door shall permit full access to the panel interior. Inner door shall permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
 - 3. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
 - 4. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

- e. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
- f. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
- g. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

2.5 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.
- B. Receive, inspect, handle, and store panelboards according to NECA 407.
- C. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install panelboards and accessories according to NECA 407. Comply with NECA 1.
- B. Mount top of trim 90 inches above finished floor, unless otherwise indicated, and after ensuring the operating handle of the top-most switch or circuit breaker, in on position, is not higher than 79 inches
- C. Mount panelboard cabinet plumb and rigid without distortion of box.
- D. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- E. Install overcurrent protective devices and controllers not already factory installed.

- F. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
- G. Install filler plates in unused spaces.
- H. Stub two 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub two 1-inch empty conduits below slabs not on grade.
- I. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: Prior to Substantial Completion Inspection perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Instruments and Equipment:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- D. Panelboards will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- F. Include test reports in Closeout Submittals.

3.5 ADJUSTING

- A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.
- B. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
 1. Measure as directed during period of normal system loading.
 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
 4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.6 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 26 24 16

SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Receptacles, receptacles with integral GFCI, and associated device plates.
- 2. Twist-locking receptacles.
- 3. Tamper-resistant receptacles.
- 4. Weather-resistant receptacles.
- 5. Floor service outlets.
- 6. Cord reels for receptacles, for a receptacle box.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.
- E. TVSS: Transient voltage surge suppressor.
- F. UTP: Unshielded twisted pair.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:

- 1. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.
- B. Field Quality Test Reports.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
 - 1. Cooper Wiring Devices; Division of Cooper Industries, Inc. (Cooper).
 - 2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
 - 3. Leviton Mfg. Company Inc. (Leviton).
 - 4. Pass & Seymour/Legrand (Pass & Seymour).
- B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
 - 1. Connectors shall comply with UL 2459 and shall be made with stranded building wire.
 - 2. Devices shall comply with the requirements in this Section.

2.3 STRAIGHT-BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; 5351 (single), CR5362 (duplex).
 - b. Hubbell; HBL5351 (single), HBL5352 (duplex).
 - c. Leviton; 5891 (single), 5352 (duplex).
 - d. Pass & Seymour; 5361 (single), 5362 (duplex).

- B. Isolated-Ground, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; IG5362RN.
 - b. Hubbell; IG5362.
 - c. Leviton; 5362-IG.
 - d. Pass & Seymour; IG5362.
 2. Description: Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.
- C. Tamper-Resistant Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, and FS W-C-596.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; TR8300.
 - b. Hubbell; HBL8300SGA.
 - c. Leviton; 8300-SGG.
 - d. Pass & Seymour; TR63H.
 2. Description: Labeled shall comply with NFPA 70, "Health Care Facilities" Article, "Pediatric Locations" Section.

2.4 GFCI RECEPTACLES

A. General Description:

1. Straight blade, feed and non-feed-through type.
2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; VGF20.
 - b. Hubbell; GFR5352L.
 - c. Pass & Seymour; 2095.
 - d. Leviton; 7590.

C. Tamper-Resistant GFCI Convenience Receptacles, 125 V, 20 A:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Hubbell; GFTR20.
 - b. Pass & Seymour; 2095TR.

2.5 TWIST-LOCKING RECEPTACLES

A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; CWL520R.
 - b. Hubbell; HBL2310.
 - c. Leviton; 2310.
 - d. Pass & Seymour; L520-R.

2.6 WALL PLATES

A. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: 0.035-inch thick, satin-finished, Type 302 stainless steel.
3. Material for Unfinished Spaces: Galvanized steel.
4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

C. Cover Plates:

1. Stainless Steel Cover Plates: Type 302 or 304, satin finish, 0.040 inch thick, accurately die cut, protected with release paper. Flush mounting plates shall be beveled with smooth rolled outer edge. Surface mounting plates shall be beveled and pressure formed for smooth edge to fit box. Single and combination plates as required to match types and sizes of specified wiring devices.
2. Weatherproof Cover Plates: Receptacles in wet locations shall be installed with a hinged outlet cover/enclosure clearly marked "Suitable For Wet Locations While in Use" and "UL Listed". There must be a gasket between the enclosure and the mounting surface, and between the hinged cover and the mounting plate/base to assure proper seal. The installation shall be in compliance with NEC Article 406.9.

3. Dust Tight Cover Plates: Receptacles in non-hazardous, high dust environments shall be installed with a gasketed, spring door cover that closes tightly automatically to protect receptacle from dust and dirt when not in use. With plug inserted, a heavy-duty gasket in the throat of the receptacle shall seal around the plug body to keep out dust and dirt. The cover shall be suitable for mounting to standard FS/FD surface or flush mounted boxes. Suitable for all NEMA configuration receptacles and toggle switches. Appleton FSK-W series or approved equal.

D. Material for unfinished spaces: Galvanized steel.

2.7 FLOOR SERVICE FITTINGS

- A. Type: Modular, flush-type, dual-service units suitable for wiring method used.
- B. Compartments: Barrier separates power from voice and data communication cabling.
- C. Service Plate: Rectangular, die-cast aluminum with satin finish.
- D. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.
- E. Voice and Data Communication Outlet: Two modular, keyed, color-coded, RJ-45 jacks for UTP cable complying with requirements in Section 271500 "Communications Horizontal Cabling."

2.8 CORD REEL

- A. Cord Reel for Receptacle
 1. Standard duty cord reel constructed with oversize main shaft, bearings, and main spring; heavy gauge cable drum and housing. High capacity slip rings, oversize brushes, and copper graphite contact points, anchored in floating brush holder.
 2. Instant action automatic lock providing positive foolproof stop at desired point, regardless of mounting position or speed of retraction
 3. Convert easily to constant tension by rotating external control
 4. Lead-in and working cables of No. 14 AWG 250 volt oil resisting safety yellow SJO cord.
 5. Large internal radius of cable guide casting to prevent snubbing and abrasion of cable.
 6. External tension adjustment to permit spring tension to be increased or decreased to meet job requirements.
 7. Lifetime lubricated, self-contained main motor springs.
 8. Declutching feature to eliminate breakage on rewind.

9. 35 ft. of 3-conductor cable.
10. Similar to “Cord Reel No. 990” by Daniel Woodhead Company.

B. Receptacle Box

1. Compact, “NeoTex” rubber compound, oil-proof and resistant to most chemicals.
2. Soft rubber, non-injurious to personnel or machinery; safe around electrical contacts.
3. Furnished with two NEMA 5-15 duplex receptacles.
4. Similar to “Box No. 3000-1” by Daniel Woodhead Company.

2.9 FINISHES

A. Device Color:

1. Wiring Devices Connected to Normal Power System: Gray unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Emergency Power System: Red.
3. Isolated-Ground Receptacles: Orange.

B. Wall Plate Color: For plastic covers, match device color.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.

2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical. Group adjacent switches under single, multigang wall plates.

H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

- A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.3 CORD REELS

- A. Mount on single channel bracket similar to “Globe Strut G-5032” with top of bracket 10 feet above finished floor.
- B. Plug lead-in cable into receptacle located 6 inches to left of bracket at same height as bracket.

3.4 IDENTIFICATION

- A. Comply with Section 260553 "Identification for Electrical Systems."
- B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Test Instruments: Use instruments that comply with UL 1436.
 - 2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- B. Tests for Convenience Receptacles:
 - 1. Line Voltage: Acceptable range is 105 to 132 V.
 - 2. Percent Voltage Drop under 15-A Load: A value of 5 percent or higher is unacceptable.
 - 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 - 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 - 5. Using the test plug, verify that the device and its outlet box are securely mounted.
 - 6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- C. Wiring device will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports and provide with Closeout Submittals.

END OF SECTION 26 27 26

SECTION 26 51 19 - LED INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Downlight.
2. Suspended, linear
3. Suspended, nonlinear.
4. Recessed Linear
5. Strip Light
6. General Building Perimeter
7. Exit Signs
8. Miniature Emergency Inverters
9. Materials.
10. Luminaire support.

B. Related Requirements:

1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. LED: Light-emitting diode.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.

3. Include physical description and dimensions of luminaires.
4. Include emergency lighting units, including batteries and chargers.
5. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.
6. Photometric data and adjustment factors based on laboratory tests, complying with IES "Lighting Measurements Testing and Calculation Guides" for each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project ES LM-79 and IES LM-80.
 - a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
 - b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
 1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.6 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications:
 1. Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
 2. Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.
- B. Provide luminaires from a single manufacturer for each luminaire type.
- C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.8 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
- B. Warranty Period: Five year(s) from date of Substantial Completion.
- C. Provide 1% attic stock of each type.

PART 2 - PRODUCTS

2.1 LUMINAIRE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Factory-Applied Labels: Comply with UL 1598. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
- C. Recessed luminaires shall comply with NEMA LE 4.

2.2 DOWNLIGHT

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Utopia.
 - 2. Barbican
 - 3. HE Williams.
- B. Nominal Operating Voltage: 120 V -277 V ac.
- C. Lamp:
 - 1. Minimum lumens - refer to luminaire schedule.
 - 2. Minimum allowable efficacy of 90.
 - 3. CRI of 80 CCT of 3500k.
 - 4. Rated lamp life of 50,000 hours to L70.
 - 5. Dimmable from 0-10 percent to zero percent of maximum light output.
 - 6. Internal driver.
 - 7. User.
 - 8. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.
- D. Housings:
 - 1. Extruded-aluminum housing and heat sink.
 - 2. powder-coat finish.
 - 3. Universal mounting bracket.
 - 4. Integral junction box with conduit fittings.

- E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- F. Diffusers and Globes:
 - 1. Fixed lens.
 - 2. Batwing light distribution.
 - 3. UV-stabilized acrylic
 - 4. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - 5. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.
- G. Standards:
 - 1. ENERGY STAR certified.
 - 2. RoHS compliant.
 - 3. UL Listing: Listed for damp location.
 - 4. Recessed luminaires shall comply with NEMA LE 4.
 - 5. Internal driver.
 - 6. User-Replaceable Lamps:
 - a. Bulb shape complying with ANSI C78.79.
 - b. Lamp base complying with ANSI C81.61
 - 7. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.
- H. Housings:
 - 1. Extruded-aluminum housing and heat sink.
 - 2. Clear anodized finish.
 - 3. With integral mounting provisions.
- I. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- J. Diffusers and Globes:
 - 1. Tempered Fresnel glass.
 - 2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - 3. Glass: Annealed crystal glass unless otherwise indicated.
 - 4. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

K. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.

2.3 SUSPENDED, LINEAR

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amerlux.
2. Coronet
3. Luminii

B. Nominal Operating Voltage: Nominal Operating Voltage: 120 V – 277 V ac

C. Lamp:

1. Refer to luminaire schedule.
2. CRI: Refer to luminaire schedule.
3. Rated lamp life of 50,000 hours to L70.
4. Dimmable from 100 percent to zero percent of maximum light output.
5. Internal driver.
6. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

D. Housings:

1. Extruded-aluminum housing and heat sink.
2. Powder-coat painted finish.
3. With integral mounting provisions.

E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

F. Diffusers and Globes:

1. UV-stabilized acrylic.
2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Glass: Annealed crystal glass unless otherwise indicated.
4. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

G. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.

2.4 SUSPENDED, NON-LINEAR

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Barbican
 2. OCL
 3. NAL
- B. Nominal Operating Voltage: Nominal Operating Voltage: 120 V – 277 V ac
- C. Lamp:
1. Refer to luminaire schedule.
 2. CRI: Refer to luminaire schedule.
 3. Rated lamp life of 50,000 hours to L80.
 4. Dimmable from 100 percent to 10 percent of maximum light output.
 5. Internal/remote driver.
 6. Retain "Lens Thickness" Subparagraph below for all diffuser and globe types.
 7. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.
- D. Housings:
1. Extruded-aluminum housing and heat sink.
 2. Powder-coat painted finish.
 3. With integral mounting provisions.
- E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- F. Diffusers and Globes:
1. UV-stabilized acrylic.
 2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 3. Glass: Annealed crystal glass unless otherwise indicated.
 4. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.
- G. Standards:
1. ENERGY STAR certified.
 2. RoHS compliant.
 3. UL Listing: Listed for damp location.

2.5 RECESSED, LINEAR

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amerlux.
 2. Coronet
 3. Luminii
- B. Nominal Operating Voltage: 120 V
- C. Lamp:
1. Minimum 1,500lm.
 2. Minimum allowable efficacy of 85lm/W.
 3. CRI of 80 CCT of 5000 K
 4. Rated lamp life of 50,000hours to L70.
 5. Dimmable from 100 percent to zero percent of maximum light output.
 6. Internal driver.
 7. User-Replaceable Lamps:
 - a. Bulb shape complying with ANSI C78.79.
 - b. Lamp base complying with IEC 60061-1.
 8. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.
- D. Housings:
1. Extruded-aluminum housing and heat sink.
 2. Powder coated finish.
 3. With integral mounting provisions.
- E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- F. Diffusers and Globes:
1. Clear, UV-stabilized acrylic.
 2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 3. Glass: Annealed crystal glass unless otherwise indicated.
 4. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.
- G. Standards:
1. ENERGY STAR certified.
 2. RoHS compliant.
 3. UL Listing: Listed for damp location.
 4. NEMA LE 4.

2.6 STRIP LIGHT

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Utpia
 2. HE Williams
 3. Coronet
- B. Nominal Operating Voltage: 120 V
- C. Lamp:
1. Minimum 4000lm.
 2. Minimum allowable efficacy of 80lm/W.
 3. CRI of 80. CCT of 3500k.
 4. Rated lamp life of 50,000 hours to L70.
 5. Dimmable from 100 percent to zero percent of maximum light output.
 6. Internal driver.
 7. User-Replaceable Lamps:
 - a. Bulb shape complying with ANSI C78.79.
 - b. Lamp base complying with IEC 60061-1.
 8. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.
- D. Housings:
1. Extruded-aluminum housing and heat sink.
 2. Anodized finish.
 3. With integral mounting provisions.
- E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping of luminaire without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- F. Diffusers and Globes:
1. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 2. Glass: Annealed crystal glass unless otherwise indicated.
 3. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

G. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.

2.7 GENERAL BUILDING PERIMETER AND GLOBES

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Utopia Lighting
2. HE Williams
3. Cree Lighting

B. Nominal Operating Voltage: 120 V -277 V ac.

C. Lamp:

1. Minimum 2,000 lm.
2. Minimum allowable efficacy of 75lm/W.
3. CRI: Refer to luminaire Schedule.
4. Rated lamp life of 50,000 hours to L70.
5. Dimmable from 100 percent to 10 percent of maximum light output.
6. Internal driver.
7. User-Replaceable Lamps:
 - a. Bulb shape complying with ANSI C78.79.
 - b. Lamp base complying with ANSI C81.61 and IEC 60061-.
8. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

D. Housings:

1. Extruded-aluminum.
2. Powder-coat finish.
3. Low-profile housing and heat sink.
4. Fully gasketed and sealed. IP 65 rated.
5. Stainless-steel latches.
6. Integral pressure equalizer.

E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

F. Diffusers and Globes:

1. Prismatic glass.
2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Glass: Annealed crystal glass unless otherwise indicated.
4. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

G. With integral mounting provisions.

H. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.

2.8 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
 - a. Battery: Sealed, maintenance-free, nickel-cadmium type.
 - b. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - f. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
 - g. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

3. Master/Remote Sign Configurations:

- a. Master Unit: Comply with requirements above for self-powered exit signs and provide additional capacity in battery for power connection to remote unit.
- b. Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply, battery, and test features. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.

2.9 MINIATURE EMERGENCY INVERTERS

- A. Provide UL 924 listed, NFPA 101 compliant maintenance-free sealed lead acid battery miniature inverters that are designed to provide power to emergency luminaires that are suitable for damp installations with LED test switch and are inclusive of the following functions:

1. Automatic output voltage select
2. Automatic dimming (0-10V) relay of connected emergency luminaires under emergency lighting conditions
3. Switched and dimmed inputs are passed through the miniature emergency inverter to the downstream emergency luminaires under normal power conditions
4. Removable/replaceable electronics module
5. Works with LED and fluorescent fixtures
6. Ideal for (but not limited to) screw-base LED lamps
7. Compatible with AC (line voltage) driven TLED lamp
8. Remote-mounting up to 1,000 feet maximum
9. 24 hour recharge time
10. Minimum VA ratings of 250 VA

2.10 LUMINAIRE SCHEDULE

- A. Refer to Luminaire Schedule on Drawings.

2.11 LUMINAIRE SUPPORT

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- C. Wires: ASTM A641/A641M, Class 3, soft temper, zinc-coated steel, 12 gage.
- D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

- A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.3 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install lamps in each luminaire.
- D. Supports:
 - 1. Sized and rated for luminaire weight.
 - 2. Able to maintain luminaire position after cleaning and relamping.
 - 3. Provide support for luminaire without causing deflection of ceiling or wall.
 - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.
- E. Flush-Mounted Luminaires:
 - 1. Secured to outlet box.
 - 2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
 - 3. Trim ring flush with finished surface.
- F. Ceiling-Grid-Mounted Luminaires:
 - 1. Secure to any required outlet box.
 - 2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
 - 3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of two locations, spaced near corners of luminaire.
- G. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
 - 2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
- B. Luminaire will be considered defective if it does not pass operation tests and inspections.
- C. Prepare test and inspection reports.

3.6 FIELD QUALITY CONTROL

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.
- B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.
- C. Remove and replace with new, all broken glassware, plastic or fixtures damaged before final acceptance at no additional expense to Owner.
- D. No allowance made for breakage or theft before final acceptance.
- E. Immediately prior to occupancy, damp clean all diffusers, glassware, fixture trims, reflectors, lamps, and replace burned- out lamps.

3.7 STARTUP SERVICE

- A. Verify all luminaires function in conjunction with lighting control system and perform as intended.
 - 1. Illumination is adequate and measured satisfactorily.
 - 2. Dimming performs satisfactorily in accordance with specification.
 - 3. 1 Hour of training of Owner includes technical information about luminaires and is completed in conjunction with lighting control specification.

3.8 UTILITY REBATES

- A. Provide Owner with all receipts for the light fixtures, luminaires, etc. eligible for current utility rebate programs at completion of Contract, allowing Owner to apply for rebates and schedule utility company inspections. Provide copy to Architect for record.

END OF SECTION 26 51 19

SECTION 26 56 13 - LIGHTING POLES AND STANDARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Poles and accessories for support of luminaires.

1.3 DEFINITIONS

- A. EPA: Equivalent projected area.
- B. Luminaire: Complete luminaire.
- C. Pole: Luminaire-supporting structure, including tower used for large-area illumination.
- D. Standard: See "Pole."

1.4 ACTION SUBMITTALS

- A. Product Data: For each pole, accessory, and luminaire-supporting and -lowering device, arranged as indicated.
 - 1. Include data on construction details, profiles, EPA, cable entrances, materials, dimensions, weight, rated design load, and ultimate strength of individual components.
 - 2. Include finishes for lighting poles and luminaire-supporting devices.
 - 3. Anchor bolts.
 - 4. Manufactured pole foundations.
- B. Shop Drawings:
 - 1. Include mounting and attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Foundation construction details, including material descriptions, dimensions, anchor bolts, support devices, and calculations, signed and sealed by a professional engineer licensed in the state of installation.

4. Anchor bolt templates keyed to specific poles and certified by manufacturer.
 5. Method and procedure of pole installation. Include manufacturer's written installations.
- C. Samples: For each exposed lighting pole, standard, and luminaire-supporting device and for each color and texture specified.

1.5 INFORMATIONAL SUBMITTALS

- A. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements according to AASHTO LTS-6-M and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations signed and sealed by a professional engineer.
- B. Qualification Data: For testing agency.
- C. Seismic Qualification Data: For accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Material Test Reports:
1. For each pole, by a qualified testing agency.
- E. Source quality-control reports.
- F. Field quality-control reports.
- G. Sample Warranty: Manufacturer's standard warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For poles to include in emergency, operation, and maintenance manuals.
1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include pole inspection and repair procedures.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Pole repair materials.

1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM C1093 for foundation testing.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Package aluminum poles for shipping according to ASTM B660.
- B. Store poles on decay-resistant skids at least 12 inches (300 mm) above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
- C. Retain factory-applied pole wrappings on poles until right before pole installation. Handle poles with web fabric straps.
- D. Retain factory-applied pole wrappings on metal poles until right before pole installation. Handle poles with web fabric straps.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of **pole(s)** that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within a specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs from special warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.
 - 2. Warranty Period for Corrosion Resistance: Five years from date of Substantial Completion.
 - 3. Warranty Period for Color Retention: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Foundation and pole shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."
 - 2. Component Importance Factor: 1.0.
- B. Structural Characteristics: Comply with AASHTO LTS-6-M.
- C. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied according to AASHTO LTS-6-M.
- D. Live Load: Single load of 500 lbf (2200 N) distributed according to AASHTO LTS-6-M.
- E. Ice Load: Load of 3 lbf/sq. ft. (145 Pa), applied according to AASHTO LTS-6-M for applicable areas on the Ice Load Map.

- F. Wind Load: Pressure of wind on pole and luminaire, calculated and applied according to AASHTO LTS-6-M.
 - 1. Basic wind speed for calculating wind load for poles 50 feet (15 m) high or less is mph 90 (40 m/s).
 - a. Wind Importance Factor: 1.0.
 - b. Minimum Design Life: 25 years.
 - c. Velocity Conversion Factor: 1.0.
- G. Strength Analysis: For each pole, multiply the actual EPA of luminaires and brackets by a factor of **1.1** to obtain the EPA to be used in pole selection strength analysis.
- H. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

2.2 ALUMINUM POLES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Visionaire Lighting.
 - 2. H.E. Williams.
 - 3. Cree Lighting.
- B. Poles: Seamless, extruded structural tube complying with ASTM B221, Alloy 6061-T6, with access handhole in in pole wall.
 - 1. Shape: REFFER TO SCHEDULE.
 - 2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
- C. Grounding and Bonding Lugs: Bolted 1/2-inch (13-mm) threaded lug, complying with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.
- D. Fasteners: Stainless steel size and type as determined by manufacturer. Corrosion-resistant items compatible with support components.
 - 1. Materials: Compatible with poles and standards as well as to substrates to which poles and standards are fastened and shall not cause galvanic action at contact points.
 - 2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
- E. Handhole: Oval shaped, with minimum clear opening of 2-1/2 by 5 inches (65 by 130 mm), with cover secured by stainless-steel captive screws.

- F. Aluminum Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.
1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.
 3. Class I, Clear-Anodic Finish: AA-M32C22A41 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I clear coating of 0.018 mm or thicker), complying with AAMA 611.
- G. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.
1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, according to SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
 2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
 3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
 - a. Color: As selected by Architect from manufacturer's full range.

2.3 POLE ACCESSORIES

- A. Duplex Receptacle: Ground-fault circuit interrupter type, 120 V ac, 20 A in a weatherproof assembly. Comply with requirements in Section 26 27 26 "Wiring Devices."
1. Surface mounted 12 inches (300 mm) above finished grade.
 - a. NEMA 250, Type 3R, nonmetallic polycarbonate plastic or reinforced fiberglass, enclosure with cover; color to match pole.
 - b. Lockable hasp and latch complying with OSHA lockout and tag-out requirements.
- B. Minimum 1800-W transformer, protected by replaceable fuses, mounted behind access cover.
- C. Base Covers: Manufacturers' standard metal units, finished same as pole, and arranged to cover pole's mounting bolts and nuts.
- D. Transformer-Type Base: Same material and color as pole. Coordinate dimensions to suit pole's base flange and to accept accessories. Include removable flanged access cover secured with bolts or screws.

2.4 MOUNTING HARDWARE

- A. Anchor Bolts: Manufactured to ASTM F1554, Grade 55, with a minimum yield strength of 55,000 psi (380 000 kPa).
 - 1. Galvanizing: Hot dip galvanized according to ASTM A153, Class C.
 - 2. Refer to drawing details.
 - 3. Threading: Uniform National Coarse Class 2A.
- B. Nuts: ASTM A563, Grade A, Heavy-Hex.
- C. Washers: ASTM F436, Type 1.
 - 1. Galvanizing: Hot dip galvanized according to ASTM A153, Class C.
 - 2. Manufacturer Recommendation for washer(s) provided per anchor bolt.

2.5 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine poles, luminaire-mounting devices, lowering devices, and pole accessories before installation. Components that are scratched, dented, marred, wet, moisture damaged, or visibly damaged are considered defective.
- C. Examine roughing-in for foundation and conduit to verify actual locations of installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 POLE INSTALLATION

- A. Alignment: Align poles as indicated.
- B. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Section 03 48 10 "Precast Concrete Lighting Pole Bases."

- C. Foundation-Mounted Poles: Mount pole with leveling nuts and tighten top nuts to torque level according to pole manufacturer's written instructions.
 - 1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
 - 2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
 - 3. Install base covers unless otherwise indicated.
 - 4. Use a short piece of 1/2 -inch (13-mm) diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

3.3 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum using insulating fittings or treatment.
- B. Steel Conduits: Comply with requirements in Section 26 05 33 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50-percent overlap.

3.4 GROUNDING

- A. Ground Metal Poles and Support Structures: Comply with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems."
 - 1. Install grounding electrode for each pole unless otherwise indicated.
 - 2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.
- B. Ground Nonmetallic Poles and Support Structures: Comply with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems."
 - 1. Install grounding electrode for each pole.
 - 2. Install grounding conductor and conductor protector.
 - 3. Ground metallic components of pole accessories and foundation.

3.5 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.6 FIELD QUALITY CONTROL

- A. Inspect poles for nicks, mars, dents, scratches, and other damage.
- B. System function tests.

END OF SECTION 26 56 13

SECTION 26 56 19 - LED EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Luminaire-mounted photoelectric relays.
2. Luminaire types.
3. Materials.
4. Finishes.
5. Luminaire support components.

B. Related Requirements:

1. Section 26 09 23 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
2. Section 26 56 13 "Lighting Poles and Standards" for poles and standards used to support exterior lighting equipment.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color rendering index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. Lumen: Measured output of lamp and luminaire, or both.
- F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of luminaire.

1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaire.

4. Lamps, include life, output (lumens, CCT, and CRI), and energy-efficiency data.
 5. Photometric data and adjustment factors based on laboratory tests, complying with IES Lighting Measurements Testing and Calculation Guides, of each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project IES LM-79 and ES LM-80.
 - a. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.
 - b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
 6. Wiring diagrams for power, control, and signal wiring.
 7. Photoelectric relays.
 8. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.
- B. Shop Drawings: For nonstandard or custom luminaires.
1. Include plans, elevations, sections, and mounting and attachment details.
 2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 3. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Luminaires.
 2. Structural members to which luminaires will be attached.
 3. Underground utilities and structures.
 4. Existing underground utilities and structures.
 5. Above-grade utilities and structures.
 6. Existing above-grade utilities and structures.
 7. Building features.
 8. Vertical and horizontal information.
- B. Qualification Data: For testing laboratory providing photometric data for luminaires.

- C. Seismic Qualification Data: For luminaires, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Product Certificates: For each type of the following:
 - 1. Luminaire.
 - 2. Photoelectric relay.
- E. Product Test Reports: For each luminaire, for tests performed by a qualified testing agency.
- F. Source quality-control reports.
- G. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires to include in operation and maintenance manuals.
 - 1. Provide a list of all lamp types used on Project. Use ANSI and manufacturers' codes.
 - 2. Provide a list of all photoelectric relay types used on Project; use manufacturers' codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Lamps: 1 for every 10 of each type and rating installed. Furnish at least one of each type.
 - 2. Glass, Acrylic, and Plastic Lenses, Covers, and Other Optical Parts: 1 for every 10 of each type and rating installed. Furnish at least one of each type.
 - 3. Diffusers and Lenses: 1 for every 10 of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications:
 - 1. Luminaire manufacturers' laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

2. Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products and complying with applicable IES testing standards.
 - B. Provide luminaires from a single manufacturer for each luminaire type.
 - C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.
 - D. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
 1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- 1.9 DELIVERY, STORAGE, AND HANDLING
- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.
- 1.10 FIELD CONDITIONS
- A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.
 - B. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.
- 1.11 WARRANTY
- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Structural failures, including luminaire support components.
 - b. Faulty operation of luminaires and accessories.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 2. Warranty Period: 5 year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance:

1. Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
2. Luminaires and lamps shall be labeled vibration and shock resistant.
3. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

2.2 LUMINAIRE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.
- C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- D. UL Compliance: Comply with UL 1598 and listed for wet location.
- E. Lamp base complying with ANSI C81.61.
- F. Bulb shape complying with ANSI C79.1.
- G. CRI of 70 CCT of 4000 K.
- H. L70 lamp life of 50,000.
- I. Lamps dimmable from 0-10 percent of maximum light output.
- J. Internal driver.
- K. Nominal Operating Voltage: 120 V – 277 V ac.
- L. In-line Fusing: Separate in-line fuse for each luminaire.
- M. Lamp Rating: Lamp marked for outdoor use.

N. Source Limitations:

1. Obtain luminaires from single source from a single manufacturer.
2. For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.

2.3 LUMINAIRE-MOUNTED PHOTOELECTRIC RELAYS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Visionaire Lighting
- B. Comply with UL 773 or UL 773A.
- C. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc (16 to 32 lx) and off at 4.5 to 10 fc (48 to 108 lx) with 15-second minimum time delay. Relay shall have directional lens in front of photocell to prevent artificial light sources from causing false turnoff.
1. Relay with locking-type receptacle shall comply with ANSI C136.10.
 2. Adjustable window slide for adjusting on-off set points.

2.4 LUMINAIRE TYPES

- A. Area and Site:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Visionaire Lighting.
 - b. Liton Outdoor
 2. Luminaire Shape: Refer to drawings.
 3. Mounting: Pole/light column.
 4. Luminaire-Mounting Height: Refer to drawings.
 5. Distribution and run time: Refer to drawings.
 6. Controls: Motion, time control and constant mode capable.
 7. Diffusers and Globes: Clear polycarbonate.
 8. Housings:
 - a. Extruded-aluminum housing and heat sink.
 - b. powder-coat finish.

2.5 MATERIALS

- A. Metal Parts: Free of burrs and sharp corners and edges.
- B. Sheet Metal Components: Stainless steel Form and support to prevent warping and sagging.
- C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses.
- D. Diffusers and Globes:
 - 1. Acrylic Diffusers: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - 2. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.
- E. Lens and Refractor Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- F. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 83 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
- G. Housings:
 - 1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.
 - 2. Provide filter/breather for enclosed luminaires.
- H. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
 - 1. Label shall include the following lamp characteristics:
 - a. "USE ONLY" and include specific lamp type.
 - b. Lamp diameter, shape, size, wattage and coating.
 - c. CCT and CRI for all luminaires.

2.6 FINISHES

- A. Variations in Finishes: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

- B. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
- C. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 - 2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.

2.7 LUMINAIRE SUPPORT COMPONENTS

- A. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

- A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is substantially complete, clean luminaires used for temporary lighting and install new lamps.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Comply with NECA 1.
- B. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- C. Install lamps in each luminaire.
- D. Fasten luminaire to structural support.

E. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Support luminaires without causing deflection of finished surface.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

F. Wiring Method: Install cables in raceways. Conceal raceways and cables.

G. Install luminaires at height and aiming angle as indicated on Drawings.

H. Coordinate layout and installation of luminaires with other construction.

I. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.

J. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" and Section 26 05 33 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

3.4 INSTALLATION OF BOLLARD LUMINAIRES (LIGHT COLUMNS)

A. Coordinate this article with Drawings. Delete if installation is detailed on Drawings.

B. Align units for optimum directional alignment of light distribution.

1. Install on concrete base as indicated on drawings.

3.5 FIELD QUALITY CONTROL

A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Verify operation of photoelectric controls.

B. Illumination Tests:

1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IES testing guide(s):
 - a. IES LM-5.
 - b. IES LM-50.
 - c. IES LM-52.
 - d. IES LM-64.
 - e. IES LM-72.

2. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
- C. Luminaire will be considered defective if it does not pass tests and inspections.
- D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain luminaires and photocell relays.

3.7 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
 1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
 2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 26 56 19

SECTION 27 11 00 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Telecommunications mounting elements.
2. Telecommunications equipment racks and cabinets.
3. Grounding.

B. Related Requirements:

1. Section 271500 "Communications Horizontal Cabling" for voice and data cabling associated with system panels and devices.

1.3 DEFINITIONS

- A. BICSI: Building Industry Consulting Service International.
- B. LAN: Local area network.
- C. RCDD: Registered Communications Distribution Designer.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.

3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 1. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of Commercial Installer, Level 2.
 2. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
 3. Field Inspector: Currently registered by BICSI as Commercial Installer, Level 2 to perform the on-site inspection.

PART 2 - PRODUCTS

2.1 EQUIPMENT FRAMES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Chatsworth Products (CPI) or comparable product by one of the following:
 1. Hubbell Premise Wiring.
 2. Leviton Commercial Networks Division.
 3. Middle Atlantic Products, Inc.
 4. Ortronics, Inc.
 5. Panduit Corp.
 6. Siemon Co. (The).
- B. General Frame Requirements:
 1. Distribution Frames: Freestanding modular-steel units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
 2. Module Dimension: Width compatible with EIA 310-D standard, 19-inch panel mounting.
 3. Finish: Manufacturer's standard, baked-polyester powder coat, black.
- C. Floor-Mounted Racks: Modular-type, steel construction.
 1. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug, and a power strip.
 2. Baked-polyester powder coat finish, black.
- D. Modular Freestanding Cabinets:
 1. Removable and lockable side panels.
 2. Hinged and lockable front and rear doors.

3. Adjustable feet for leveling.
4. Screened ventilation openings in the roof and rear door.
5. Cable access provisions in the roof and base.
6. Grounding bus bar.
7. Roof-mounted, 550-cfm fan with filter.
8. Power strip.
9. Baked-polyester powder coat finish, black.
10. All cabinets keyed alike.

E. Cable Management for Equipment Frames:

1. Metal, with integral wire retaining fingers.
2. Baked-polyester powder coat finish.
3. Vertical cable management panels shall have front and rear channels, with covers.
4. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.

2.2 POWER STRIPS

A. Power Strips: Comply with UL 1363.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Rack mounting.
3. Six 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R receptacles.
4. LED indicator lights for power and protection status.
5. LED indicator lights for reverse polarity and open outlet ground.
6. Circuit Breaker and Thermal Fusing: Unit continues to supply power if protection is lost.
7. Peak Single-Impulse Surge Current Rating: 26 kA per phase.
8. Protection modes shall be line to neutral, line to ground, and neutral to ground. UL 1449 clamping voltage for all three modes shall be not more than 330 V.

2.3 GROUNDING

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Telecommunications Primary Bus Bar:

1. Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
2. Ground Bus Bar: Copper, minimum 1/4 inch thick by 4 inches wide (6 mm thick by 100 mm wide) with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart.
3. Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

C. Comply with J-STD-607-A.

2.4 LABELING

- A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Comply with BICSI TDMM for layout and installation of communications equipment rooms.
- C. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- D. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.
 - 1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
 - 2. Record agreements reached in meetings and distribute them to other participants.
 - 3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.
 - 4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.

3.2 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-B, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.3 GROUNDING

- A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. Comply with J-STD-607-A.

- C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
- D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.
 - 1. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

3.4 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements in Section 260553 "Identification for Electrical Systems."

END OF SECTION 27 11 00

SECTION 27 15 00 - COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. UTP cabling.
 - 2. 50/125-micrometer, optical fiber cabling.
 - 3. Cable connecting hardware, patch panels, and cross-connects.
 - 4. Telecommunications outlet/connectors.
 - 5. Cabling system identification products.
 - 6. Cable management system.

1.3 DEFINITIONS

- A. BICSI: Building Industry Consulting Service International.
- B. Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.
- C. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- D. EMI: Electromagnetic interference.
- E. IDC: Insulation displacement connector.
- F. LAN: Local area network.
- G. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.
- H. RCDD: Registered Communications Distribution Designer.
- I. UTP: Unshielded twisted pair.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate layout and installation of telecommunications cabling with Owner's telecommunications and LAN equipment and service suppliers.
- B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.

B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
3. Cabling administration drawings and printouts.
4. Wiring diagrams to show typical wiring schematics, including the following:
 - a. Cross-connects.
 - b. Patch panels.
 - c. Patch cords.
5. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.
- B. Source quality-control reports.
- C. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For splices and connectors to include in maintenance manuals.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Patch-Panel Units: Three of each type.
 2. Communications Outlets: Twenty of each type.
 3. Device Plates: Twenty of each type.

1.9 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 1. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.

2. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site.
 1. Test optical fiber cables to determine the continuity of the strand end to end. Use optical fiber flashlight or optical loss test set.
 2. Test optical fiber cables while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; including the loss value of each. Retain test data and include the record in maintenance data.
 3. Test each pair of UTP cable for open and short circuits.

PART 2 - PRODUCTS

2.1 HORIZONTAL CABLING DESCRIPTION

- A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called a "permanent link," a term that is used in the testing protocols.
 1. TIA/EIA-568-B.1 requires that a minimum of two telecommunications outlet/connectors be installed for each work area.
 2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
 3. Bridged taps and splices shall not be installed in the horizontal cabling.
 4. Splitters shall not be installed as part of the optical fiber cabling.
- B. A work area is approximately 100 sq. ft., and includes the components that extend from the telecommunications outlet/connectors to the station equipment.
- C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

2.2 PERFORMANCE REQUIREMENTS

- A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA/EIA-568-B.1 when tested according to test procedures of this standard.

- B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 50 or less.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Grounding: Comply with J-STD-607-A.

2.3 UTP CABLE

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide Berk-Tek or comparable product by one of the following:
 - 1. Belden Inc.
 - 2. CommScope, Inc.
 - 3. Draka Cableteq USA.
 - 4. Mohawk; a division of Belden Networking, Inc.
 - 5. Superior Essex Inc.
 - 6. SYSTIMAX Solutions; a CommScope, Inc. brand.
 - 7. Tyco Electronics Corporation; AMP Products.
- C. Description: Provide horizontal copper cable, UTP, 100 ohm in accordance with TIA-568-C.2, UL 444, ANSI/NEMA WC 66, ICEA S-90-661. Provide four each individually twisted pair, minimum size 24 AWG conductors, Category 6, with a blue thermoplastic jacket. Cable shall be imprinted with manufacturers name or identifier, flammability rating, gauge of conductor, transmission performance rating (category designation) and length marking at regular intervals in accordance with ICEA S-90-661. Provide plenum (CMP), communications rated cabling in accordance with NFPA 70. Substitution of a higher rated cable shall be permitted in accordance with NFPA 70. Cables installed in conduit within and under slabs shall be UL listed and labeled for wet locations in accordance with NFPA 70.

2.4 UTP CABLE HARDWARE

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide Leviton or comparable product by one of the following:
 - 1. Belden Inc.
 - 2. Hubbell Premise Wiring.
 - 3. Panduit Corp.

4. Siemon Co. (The).
 5. Tyco Electronics Corporation; AMP Products.
- C. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.
- D. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.
- E. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.
1. Number of Terminals per Field: One for each conductor in assigned cables.
- F. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.
1. Number of Jacks per Field: One for each four-pair UTP cable indicated.
- G. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.
- H. Patch Cords: Factory-made, four-pair cables in 24 inch, 48 inch, 84 inch and 120 inch lengths; terminated with eight-position modular plug at each end.
1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
 2. Patch cords shall have color-coded boots for circuit identification.

2.5 OPTICAL FIBER CABLE

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide Berk-Tek or comparable product by one of the following:
1. Belden Inc.
 2. CommScope, Inc.
 3. Corning Cable Systems.
 4. CSI Technologies Inc.
 5. General Cable Technologies Corporation.
 6. Mohawk; a division of Belden Networking, Inc.
 7. Superior Essex Inc.
 8. SYSTIMAX Solutions; a CommScope, Inc. brand.
 9. Tyco Electronics Corporation; AMP Products.

- C. Description: Multimode, 50/125-micrometer, 24-fiber, nonconductive, tight buffer, optical fiber cable.
1. Comply with ICEA S-83-596 for mechanical properties.
 2. Comply with TIA/EIA-568-B.3 for performance specifications.
 3. Comply with TIA-492AAAB for detailed specifications.
 4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
 - a. General Purpose, Nonconductive: Type OFN or OFNG, or OFNR, OFNP.
 - b. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
 - c. Riser Rated, Nonconductive: Type OFNR or OFNP, complying with UL 1666.
 - d. General Purpose, Conductive: Type OFC or OFCG; or OFNG, OFN, OFCR, OFNR, OFCP, or OFNP.
 - e. Plenum Rated, Conductive: Type OFCP or OFNP, complying with NFPA 262.
 - f. Riser Rated, Conductive: Type OFCR; or OFNR, OFCP, or OFNP, complying with UL 1666.
 5. Conductive cable shall be steel armored type.
 6. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.
 7. Minimum Modal Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm.
- D. Jacket:
1. Jacket Color: Aqua for 50/125-micrometer cable.
 2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-C.
 3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

2.6 OPTICAL FIBER CABLE HARDWARE

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide Berk-Tek or comparable product by one of the following:
1. Belden Inc.
 2. Corning Cable Systems.
 3. CSI Technologies Inc.
 4. Dynacom Inc.
 5. Hubbell Premise Wiring.
 6. Molex Premise Networks; a division of Molex, Inc.
 7. Simon Co. (The).

- C. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.
 - 1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.
- D. Patch Cords: Factory-made, dual-fiber cables in 36-inch lengths.
- E. Cable Connecting Hardware:
 - 1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA-604-2-B, TIA-604-3-B, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.
 - 2. Quick-connect, simplex and duplex, Type LC connectors. Insertion loss not more than 0.75 dB.
 - 3. Type SFF connectors may be used in termination racks, panels, and equipment packages.

2.7 TELECOMMUNICATIONS OUTLET/CONNECTORS

- A. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA/EIA-568-B.1.
- B. Workstation Outlets: Port-connector assemblies mounted in multigang faceplate.
 - 1. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."
 - 2. For use with snap-in jacks accommodating any combination of UTP, optical fiber work area cords.
 - a. Flush mounting jacks, positioning the cord at a 45-degree angle.
 - 3. Legend: Snap-in, clear-label covers and machine-printed paper inserts.

2.8 GROUNDING

- A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.
- B. Comply with J-STD-607-A.

2.9 IDENTIFICATION PRODUCTS

- A. Comply with TIA/EIA-606-A and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- B. Comply with requirements in Section 260553 "Identification for Electrical Systems."

2.10 SOURCE QUALITY CONTROL

- A. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-B.1.

- B. Factory test UTP cables according to TIA/EIA-568-B.2.
- C. Cable will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 WIRING METHODS

- A. Install cables in pathways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal pathways and cables except in unfinished spaces.
 - 1. Install plenum cable in all locations.
- B. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- C. Wiring within Enclosures:
 - 1. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
 - 2. Install lacing bars and distribution spools.
 - 3. Install conductors parallel with or at right angles to sides and back of enclosure.

3.2 INSTALLATION OF CABLES

- A. Comply with NECA 1.
- B. General Requirements for Cabling:
 - 1. Comply with TIA/EIA-568-B.1.
 - 2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
 - 3. Install 110-style IDC termination hardware unless otherwise indicated.
 - 4. MUTOA shall not be used as a cross-connect point.
 - 5. Consolidation points may be used only for making a direct connection to telecommunications outlet/connectors:
 - a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
 - b. Locate consolidation points for UTP at least 49 feet from communications equipment room.
 - 6. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.

7. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
8. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
9. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
10. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
11. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
12. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-B.2.
2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.

D. Optical Fiber Cable Installation:

1. Comply with TIA/EIA-568-B.3.
2. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

F. Group connecting hardware for cables into separate logical fields.

G. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-B for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.

2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.3 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-B, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.4 GROUNDING

- A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. Comply with J-STD-607-A.
- C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
- D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.5 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
 - 1. Administration Class: 3.
 - 2. Color-code cross-connect fields. Apply colors to voice and data service backboards, connections, covers, and labels.
- B. Using cable management system software specified in Part 2, develop Cabling Administration Drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable and label cable, jacks, connectors, and terminals to which it connects with same designation. At completion, cable and asset management software shall reflect as-built conditions.
- C. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 3 level of administration, including optional identification requirements of this standard.
- D. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
- E. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of TIA/EIA-606-A. Furnish electronic record of all drawings, in software and format selected by Owner.
- F. Cable and Wire Identification:
 - 1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
 - 2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
 - 3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
 - 4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
 - a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
 - b. Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
 6. Uniquely identify and label work area cables extending from the MUTOA to the work area. These cables may not exceed the length stated on the MUTOA label.
- G. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA-606-A.
1. Cables use flexible vinyl or polyester that flex as cables are bent.

3.6 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-B.1.
2. Visually confirm Category 6A, marking of outlets, cover plates, outlet/connectors, and patch panels.
3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
4. Test UTP backbone copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
 - a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
5. Optical Fiber Cable Tests:
 - a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
 - b. Link End-to-End Attenuation Tests:
 - 1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in 1 direction according to TIA-526-14-A, Method B, One Reference Jumper.

- 2) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-B.1.
6. UTP Performance Tests:
 - a. Test for each outlet and MUTOA. Perform the following tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.2:
 - 1) Wire map.
 - 2) Length (physical vs. electrical, and length requirements).
 - 3) Insertion loss.
 - 4) Near-end crosstalk (NEXT) loss.
 - 5) Power sum near-end crosstalk (PSNEXT) loss.
 - 6) Equal-level far-end crosstalk (ELFEXT).
 - 7) Power sum equal-level far-end crosstalk (PSELFEXT).
 - 8) Return loss.
 - 9) Propagation delay.
 - 10) Delay skew.
7. Optical Fiber Cable Performance Tests: Perform optical fiber end-to-end link tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.3.
8. Final Verification Tests: Perform verification tests for UTP and optical fiber systems after the complete communications cabling and workstation outlet/connectors are installed.
 - a. Voice Tests: These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.
 - b. Data Tests: These tests assume the Information Technology Staff has a network installed and is available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.
- B. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.
- C. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.7 DEMONSTRATION

- A. Train Owner's maintenance personnel in cable-plant management operations, including changing signal pathways for different workstations, rerouting signals in failed cables, and keeping records of cabling assignments and revisions when extending wiring to establish new workstation outlets

END OF SECTION 27 15 00

SECTION 27 51 25 – CAFETORIUM AUDIO SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes

1. Complete operating system (racks, equipment, loudspeakers, mounting hardware, wire, connectors, terminations, raceways and all required accessories) for the pickup, amplification, distribution, recording and reproduction of voice and/or other audio program material.
2. Assistive listening system.
3. Wireless microphone systems.
4. All necessary interconnecting cable and connections.
5. System programming, equalization and training.
6. Connection to main building public address system for emergency all-call override.
7. Provide labor, materials, services & equipment necessary to supply, install and demonstrate Audio & AV work as shown on the drawings, specified herein.
8. Provide interconnection with the fire alarm system to provide a cut out relay. When fire alarm system is activated the auditorium audio system outputs will be turned off.
9. Provide interconnection with the local PA system to provide a cut out relay. When a local PA announcement is made, the auditorium audio system outputs will be turned off.
10. Utilize EASE software prior to shop drawing submission to verify speaker coverage.

B. Related Sections

1. SECTION 26 05 00 – Common Work Results for Electrical

1.3 SYSTEM REQUIREMENTS

A. Supply and install:

1. Audio system for performances
2. Audio system for multimedia presentation
3. Audio system for public address
4. Multimedia system for DVD, VGA and video projection
5. Assisted Listening system for hearing impaired
6. Performance Intercom System for lighting, audio, stage and green room communications

B. Installation requirements shall be:

1. Supply equipment specified on drawings and in Bill of Materials(BOM)
2. Assemble into complete properly functioning systems
3. Install as per specifications and drawings.
 - a. Provide all high voltage and low voltage wiring and complete all high voltage terminations
 - b. Provide all low voltage terminations.
4. Assemble racks fully prewired and tested prior to delivery to job site.
5. Assume full responsibility for providing and installing systems that meet the performance and functional requirements stated not withstanding detailed information within this specification or on accompanying drawings.
6. Provide programming of system presets including equalization and other control settings
7. Provide customer training of the installed system(s)
8. Provide all and any components necessary that may not be shown or listed but are required for a fully functioning system(s) to the intent of the specification.
9. Provide and install all conduits, pull boxes, back boxes and raceways.
 - a. Custom back boxes for custom Audio and AV panels.
10. Provide and install all wire and cable between panels, boxes, connection plates, audio devices and racks.
11. Install and terminate all high voltage wiring and devices.
12. Speakers shall be installed, mounted and rigged by a certified theatrical rigger engaged by the contractor.

C. All terminations testing and system testing by contractor

- D. Where equipment components, materials, hardware and or services have been omitted from the drawings and specifications, but are required for a fully functional system, they shall be assumed to be included and shall be provided without claim for change to the Contract price by the contractor.
- E. Contractor shall provide onsite warranty including all labor and materials service contract for one year from date of system demonstration.
- F. Contractor shall provide onsite warranty including all labor and materials for one year for all equipment mounting, wiring and terminations.

1.4 QUALITY ASSURANCE

- A. Work shall be performed by labor skilled in Professional Audio and Multimedia System installations. AV technicians shall all be CSA certified. No Exceptions
- B. The equipment specified herein has been selected for its operational, functional, maintenance, and or aesthetic suitability for this project. Equivalents must meet or exceed all of the qualifications of the specified equipment to be considered.

1.5 QUALIFICATIONS

- A. The contractor shall be an authorized representative for the specified manufacturers. This contractor shall provide all services related to the work specified and shall exercise technical and engineering supervision over the completed installation.

1.6 CONTRACTOR STANDARDS AND REFERENCES

- A. The CONTRACTOR is responsible for the provision of material and methods for installation of equipment conforming to the currently applicable standards of:
 - 1. ADA -Americans with Disabilities Act
 - 2. AISC -American Institute of Steel Construction
 - 3. AISI -American Iron and Steel Institute
 - 4. ANSI -American National Standards Institute
 - 5. ASME -American Society of Mechanical Engineers
 - 6. ASTM -American Society for Testing Materials
 - 7. FCC -Federal Communications Commission
 - 8. IEC -International Electronics Commission
 - 9. NEC -The National Electric Code
 - 10. NEMA -National Electrical Manufacturers Association
 - 11. NFPA -National Fire Protection Association
 - 12. OSHA -Occupational Safety and Health Association
 - 13. SAE -Society of Automotive Engineers
 - 14. SMPTE -Society of Motion Picture and Television Engineers

- B. UL -Underwriters Laboratories. All electrical components, devices and accessories shall bear a UL label where applicable. UL listed and labeled as defined by NFPA70, article 100, by a testing agency acceptable to authorities having jurisdiction and marked for intended use.
- C. USITT-United States Institute for Theater Technology "Recommended Guidelines for stage rigging and stage machinery-specifications and practices".
- D. Provide certification and labels where applicable. Comply with Federal, State, and Local regulations and applicable union regulations where required. All equipment will be furnished with the proper labels for New York State.
- E. Provide only equipment that is standard new equipment, the latest model of regular stock product, and is furnished with all parts regularly used with the equipment offered for the purpose intended. The contractor guarantees that no modification of the equipment has been made contrary to the manufacturer's regular practice.
- F. Review all materials and equipment prior to installation and notify owner as to any changes or discrepancies between published specifications and the actual material and equipment to be installed.
- G. Applicable codes, standards, regulations and guidelines shall be adhered to in both spirit and letter of intent.

1.7 SUBMITTALS

- A. Comply with requirements of SECTION 01 33 00 – Submittal Procedures and as modified below.
- B. Provide a complete bill of materials listing all components, quantities, manufacturers and model numbers.
- C. Submit technical data specification sheets on all items including cables, wire types, multi-pin connectors, snakes, etc. Specification sheets shall be complete, clear and legible.
- D. Submit outline drawing(s) of fixed equipment and portable equipment racks showing the relative position of all major components, thermal management, etc. Drawing(s) shall be created using a program similar to Visio. Hand drawn drawings are not acceptable and will be rejected.
- E. Submit shop drawing(s) in plan view indicating floorplans, physical location of all equipment, wiring paths, speaker placements, aiming, connections and controls. Drawing(s) shall be created using a CAD program. Hand drawn drawings are not acceptable and will be rejected.
- F. Submit shop drawing(s) of system one-line riser, showing entire system, components, point-to-point wiring, connectors and field connections. Riser must clearly identify all interconnections between equipment, wire types and connectors to be used. Drawing(s) shall be created using a CAD program. Hand drawn drawings and modified copies of the original construction documents are not acceptable and will be rejected.

- G. Submit shop drawing(s) of all loudspeakers rigging to be used. Rigging submittal to include all of the following: bill of materials, cluster drawings, assembly drawings, weights and calculations, tilt cable geometry and proof and method of attachment to the building structure. Rigging submittal must be approved and stamped by a professional structural engineer licensed in the state of New York.
- H. Quality Control Submittals
1. To ensure a quality project and proper warranty coverage for the system specified, the Contractor must submit the following:
 - a. Provide evidence that the Contractor who will furnish and install the equipment has been in the business of installing commercial audio systems for at least five (5) years.
 - b. Provide references of at least three (3) installations of comparable scope performed by the Contractor, including location, system description and names, addresses and telephone numbers of the Architects, Consultants and Owners, with contact names for each.
 - c. Provide written proof that Contractor's personnel are properly trained and certified to install rigging.
 - d. Provide written proof that Contractor's personnel are properly trained and certified to install, test and program digital signal processors (DSP's).
 - e. Provide evidence of the ability and intent to meet the guarantee and service requirements included in this specification.
 - f. Provide documentation that Contractor who will furnish and install system maintains service facilities and will have service personnel available on-site within 24 hours.
 2. Contractor who will furnish and install system must be a factory authorized dealer for all products submitted and must submit such proof in writing or in the form of authorized agreements with the various manufacturers.

1.8 WARRANTY

- A. Special Warranty: Guarantee system against defective materials, design, workmanship, and improper adjustment for period of (1) year from date of final acceptance.
1. Provide restoration of service within 24 hours of report of malfunction, weekends and holidays included, at no additional cost to Owner during guarantee period. Provide approved temporary alternate equipment and facilities, complete and operational, at no additional cost to Owner within 24 hours if defects cannot be corrected within that period.

2. The field supervisor and project manager shall be present at the systems turn on, checkout and testing and owner training sessions. Make necessary repairs and advise on Field installation nuances at time of training.
3. Training shall consist of a four-hour session at a time mutually agreeable to the Owner.
4. For the first (30) days after final acceptance of the system, the contractor shall be required to answer all service calls within twenty-four hours of a request being made. After the (30) day period, the contractor shall meet all requirements established by the one-year warranty.
5. Permanently replace any equipment that exhibit similar failures 3 times within guarantee period.
6. Provide (2) semi-annual preventive maintenance service visits during guarantee period at no additional cost. Schedule visits with and solicit information regarding failures, intermittences, and other matters from Owner. Confirm proper equipment operation and perform manufacturer recommended maintenance work during these visits.
 - a. Allow for (2) additional onsite visits (4 hours each not inclusive of travel time) to clarify misunderstandings regarding proper system operation on part of Owner's operating personnel at no additional cost to Owner.

1.9 SYSTEM DESCRIPTIONS

A. Cafetorium Audio System

1. Audio system shall be dual function: a mixing console for manual control of the system and an automatic mixer for automatic control. A DSP will provide signal processing and routing, signal delay, compression, limiting, filtering, feedback suppression, and graphic and parametric equalization.
2. Loudspeakers:
 - a. The audio system will operate as a linear array.
 - b. Stage Monitors: The monitors shall consist of (2) two-way, full-range speakers.
3. Hearing Assistance: An RF assistive listening system will be installed in the auditorium to be utilized by persons with hearing disabilities. Hearing assistance will be provided in all operating modes.
4. Wireless microphones.
5. Wired microphones and wiring.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Where equipment, components, support devices, anchoring systems or internal rack wiring systems have been omitted from the specifications or drawings, but are necessary for the operation of the system, they shall be provided and installed without claim for additional payment or time.
 - 1. Structural supports, anchoring surfaces, or steel behind walls and above finished ceilings shall be provided.
 - 2. All interconnecting conduit, pull boxes, wire troughs, wire and cable shall be provided.
- B. Items, materials and equipment shall be new and undamaged. Uniform materials shall be used throughout. All steelworks shall be cleaned, primed with rust inhibitor and painted with epoxy resin or baked enamel finish. Repair damage to factory finishes. All touch-up paint shall match the manufacturer's color identically. Performance Requirements
- C. Performance Requirements
 - 1. The requirements of the referenced equipment are not generic in nature. Specific performance, control and routing capabilities are necessary for any alternate equipment. The details herein of the functional description and manufacturers descriptions of the system components are the critical criteria for selection of each piece of equipment.
 - 2. In bidding equipment from different manufacturer of those specified herein, be aware that specifications, physical size, serviceability, warranty terms, product availability, and other non-technical issues will be used in determining the factors in product equivalents. Final judgment as to an equivalency will be solely that of the owner, architect and consultant.
 - 3. Substitution Criteria:
 - a. Loudspeaker's substitutions require proof that the substituted product meets all performance requirements including but not limited to:
 - 1) Frequency Response -On and off axis
 - 2) Directivity by frequency
 - 3) Distortion
 - 4) Phase response
 - 5) Number of Drivers
 - 6) Power Handling Capacity and Maximum Output
 - 7) Weight
 - 8) Powering Method
 - b. Amplifiers require proof substitutions require proof that the substituted product meets all performance requirements including but not limited to:
 - 1) Power at all impedances
 - 2) Damping Factor

- 3) Slew rate
 - 4) Terminal Types
 - 5) Indicator and control capabilities
 - 6) Ability to install with security covers
 - 7) Sonic Character
 - 8) Input Power requirements
 - 9) Cooling Method –Fan speed and air flow direction Heat Output
- c. Digital Signal Processors substitutions require proof that the substituted product meets all performance requirements including but not limited to:
- 1) A/D Converters type and sampling rate
 - 2) Number of Processors, Mixers, automixer, feedback Suppressors, equalizers, and dynamics devices.
 - 3) FIR Capability where required by design.
 - 4) Expandability where applicable
 - 5) Configuration Capability -Ability to configure as per the specified model.
 - 6) Interface to other devices digitally where applicable.
 - 7) Physical Size
 - 8) Terminals
 - 9) Control software and ability to be controlled via wireless.
- d. Mixing Console substitutions require proof that the substituted product meets all performance requirements including but not limited to:
- 1) A/D Converters type and sampling rate
 - 2) Number of inputs/outputs and types
 - 3) Number of EFX processors, equalizers, and dynamics devices.
 - 4) Ability to create custom pages and configuration via preset scene change.
 - 5) Input Delay
 - 6) Fade Rate by scene
 - 7) Expandability where applicable
 - 8) Configuration Capability -Ability to configure as per the specified model.
 - 9) Interface to other devices digitally where applicable.
 - 10) Physical Size
 - 11) Connect ability
 - 12) Control software and ability to be controlled via external computer and wireless.
- e. Microphone Substitutions require proof that the substituted product meets all performance requirements including but not limited to:
- 1) Frequency response
 - 2) Pattern Consistency
 - 3) Capsule Type On/Off switch or none.
 - 4) Physical Size.
- f. Video Projector Substitutions require proof that the substituted product meets all performance requirements including but not limited to:
- 1) Native resolution

- 2) Alternate resolution capabilities
- 3) Input power requirements
- 4) dB noise output of fixture at full intensity with cooling fan at top speed
- 5) Cooling fans present
- 6) Built-in scaling capabilities (if applicable)
- 7) Quantity, wattage and type of lamp(s) Intelligent lens system availability and operation
- 8) Recallable preset lens locations
- 9) Lens options (including fixed, wide angle, zoom and distance throw) Aspect ratio
- 10) Content capabilities (SO, HO, etc.) Overall physical weight
- 11) Mounting options RS-232, Network or other remote interface capabilities
- 12) Registration & calibration line and color bar test patterns built in
- 13) Warranty period and limitations of coverage

g. Projection Screen Substitutions require proof that the substituted product meets all performance requirements including but not limited to:

- 1) Physical screen case construction materials.
- 2) Physical size of screen case
- 3) Motorized options
- 4) Low voltage remote location control capabilities and options
- 5) Screen material
- 6) Seamless screen in size(s) indicated
- 7) Quantity of black extra drop material available for intended screen size
- 8) Aspect ratio
- 9) Input power requirements

h. Wire substitutions require proof that the substituted product meets all performance requirements including but not limited to:

- 1) UL rating
- 2) Jacket Type
- 3) Number of Conductors
- 4) Conductor arrangement and shielding type
- 5) Jacket shape-round, twisted etc
- 6) Number of strands and gauge
- 7) Flexibility Capacitance and resistance conductor-to-conductor as well as single conductor
- 8) Fire Code rating
- 9) Voltage rating

D. Items not indicated on drawings or listed herein but necessary for the project shall be included at no additional cost to the owner.

E. Cables

1. Provide serial interface cables, infrared emitters, and line amplifiers as required to control devices shown on the Drawings.

2.2 PROJECTION SCREEN

- A. Large electrically operated, tab tensioned, extruded aluminum case. Projection screen with motor in roller. Case fully enclosed except for slot allowing viewing surface passage. Roller: 6 inches (152 mm) diameter steel tube. Viewing surface securely attached to roller at top and at bottom to weighted dowel. Provided with universal mounting brackets for ceiling or above ceiling mounting. Custom brackets as necessary to mount to batten.
- B. Motor UL certified, rated 110-120V AC, 60 Hz, three wire, instantly reversible, lifetime lubricated with pre-set accessible limit switches.
- C. Motor Screen Controls, UL certified.
 - 1. Low voltage control unit with three button 24V switches and cover plate to stop or reverse screen at any point, built-in RF receiver, built-in Video Interface Control trigger for 3V-28V, RS232, and dry contact relays.
- D. Projection Viewing Surface:
 - 1. TecVision XH900X Grey - On Axis gain of 0.9. 180 degree viewing cone. Provides very good contrast and color reproduction. Imaging Science Foundation certified. 4K ready. Dark backing or approved equal.
 - 2. Tab-Tensioning System.
 - 3. Viewing surface with integrated tabs and cable on each side of fabric to provide tension and ensure flat viewing surface. Viewing surface and tabs CNC cut as a single piece. Tabs RF welded to the back of viewing surface to prevent tab separation. Tab adhesives are not acceptable. Warranted for 5 years against tab separation. Viewing surface inserted into aluminum bottom dowel
 - 4. Viewing Area: Appropriate for Auditorium
 - 5. 16:10 Format. Black masking borders standard.
 - 6. 335-inch (8230 mm) diagonal, 177 inches x 284 inches (4496 mm x 5994 mm) to be verified in field with owner/owner representative.
 - 7. Provide an extra screen drop as border.

2.3 SYSTEM EQUIPMENT LISTING (BOM)

Category	Manufacturer	Model	Qty
Digital Mixer	Allen & Heath	SQ-5	1
Wireless Mic Receiver	Shure	ULXD4Q	1
Wireless Handheld Mic	Shure	ULXD2/SM58	4
Wireless Bodypack	Shure	ULXD1	2
Lavalier Mic	Shure	WL185	2
Ceiling/Wall Speaker	JBL	Control 65P/T	6
Main PA Speaker	QSC	K12.2	2
Subwoofer	QSC	KS112	2
Linear Array Speaker	JBL	VRX932LA-1	4
Linear Array Subwoofer	JBL	VRX918S	2
Array Frame	JBL	VRX-AF	1
Amplifier	Crown	I-Tech 4x3500HD	1
Assistive Listening Transmitter	Listen Technologies	LT-800	1
Assistive Listening Receiver	Listen Technologies	LR-4200	4
Universal Headphones	Listen Technologies	LA-403	10
Projector	Epson	Pro L630U	1
Projection Screen	Da-Lite	Advantage Electrol	1
Secondary Display	Samsung	QM75B	2
PTZ Camera	Panasonic	AW-UE4	1
Video Switcher	Extron	DXP HD 4K Series	1
Control Processor	Crestron	CP4	1
Touchscreen Interface	Crestron	TSW-1070	1

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Examine conditions under which audio system is to be installed in coordination with Installer of materials and components specified in this Section and notify affected Prime Contractors and Architect in writing of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

- B. When Installer confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to Architect written confirmation from applicable Installer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to Installer.

3.2 INSTALLATION

- A. Conduit: Use separate steel conduits for microphone level circuits (below -20 dBm), line-level circuits (up to +30 dBm), loudspeaker circuits (above +30 dBm), control lines, and AC power circuits. Space audio conduits well away from the power conduit system. Insulate all conduits from the equipment rack; ground conduit only to power system ground.
- B. Cable: Do not exceed 30 percent fill or splice lines in conduit. Connect each input receptacle by individual, insulated line to system equipment rack. Exercise care to avoid damage to cables and equipment. Do not splice lines in conduit. Provide all microphone and loudspeaker wiring in continuous runs without intervening splices.
- C. System Shielding and Grounding: Ground each shield at only one point. Insulate shields at the floating end with heat-shrink or wedge-on collars. Connect all audio grounds to isolated grounding bus bar in equipment rack. Ground this point and track to building main service ground point using ground cable sized for DC resistance of 0.1 ohm or less. Use isolated ground receptacles for all audio system power. Connect these receptacle grounds together and terminate them only to equipment rack ground.
- D. Connectors: Terminate three-pin/socket connectors for Pin 1 = shield, Pin 2 = high, Pin 3 = low. Make all joints and connections with rosin core solder or approved mechanical connectors.
- E. Provide all wiring in strict conformance with standard broadcast practices. Dress cables in conveniently sized bundles of cables, combed into parallel runs, either laced or banded with sufficient plastic ties. Cabling to each piece of equipment neatly incorporates “service loop” of sufficient length to permit equipment to be pulled forward from rack for servicing. Cables and cable bundles supported with sufficient plastic ties and support bars to ensure that strain is not placed on any connections or connectors. Cables and cable bundles behind patch bays sufficiently well organized to permit easy access to patch panels to add or remove cables.
- F. Audio Patch Panels: Wire normalised pairs of jacks together located vertically adjacent except as indicated. Locate output jacks in top row and input jacks in bottom row except as indicated. Label each horizontal row of jacks by letter and each jack by number. Also label each jack according to function (i.e. “Automix Main Out”).
- G. Labels:
 - 1. Label all equipment items, device plates, equipment rack panels, devices, receptacles and cables, and all controls not protected by security covers as to function performed and area served.

2. Identify all wires and cables at every termination and connection point. Place cable markers within 6 inches of each termination. Use identical designations at each end of cable and carry designations through any intermediate terminations. Protect all cable markings beneath clear heat-shrink.
3. Label manufactured equipment items as to their function and all unsecured controls as to areas and receptacles served. Employ panels with black or colored background to match finish of equipment item and white contrasting engraved Helvetica lettering. Mark nominal operating positions of all unsecured controls.

H. Equipment Racks:

1. Install equipment in rack to permit access to all equipment for service. Do not allow transformers, relays, terminal blocks mounted in rear of rack behind other equipment to prevent access to other equipment connections or mounted on hinged panels to permit access.
2. Arrange equipment to prevent temperatures from rising above 100 degrees Fahrenheit with ambient room temperature of 70 degrees F. Allow one rack unit between amplifiers. Use ventilating panels as required.
3. Wire rack completely in supplier=s shop. Use one-pair, 22AWG, stranded, foil-shielded and jacketed cable for all internal microphone and line level wiring and one pair 16AWG, stranded and jacketed cable for internal loudspeaker level wiring. Separate microphone, line, loudspeaker, and AC power level cables in rack as much as possible, crossing lines only at right angles. Use rosin-core solder and/or approved connectors for all equipment terminations.
4. Connect all microphone, line, loudspeaker level and DC control cables to equipment rack using specified terminal blocks. Label screw positions as to cable served and conductors of that cable. External lines connected to patch bays terminated directly to patch bay terminal blocks.
5. Locate equipment having operator controls and indicators centered at 60 inches above floor. Locate patch bays no lower than 30 inches above floor.
6. Fill all unused rack space with black blank or vent panels.

I. Equipment Installation

1. Loudspeaker Cluster:
 - a. Assemble indicated loudspeakers into center cluster assembly and mount close to ceiling in front center of cafetorium.
 - b. Rigidly fasten elements of speaker cluster to each other and to building roof structure above ceiling.
 - c. In addition to rigid fastening system provided for cluster assembly, provide back-up support system (safety cable) attached at building roof structure.

- d. Fasten all parts of cluster to each other and to building structure using materials and methods with safety factor of (5) or greater. Weight of loudspeaker elements borne by structural supports; designs relying on integrity of horn/loudspeaker cabinets in their support not acceptable.
 - e. Loudspeakers may not be field modified by the contractor for installation by suspension. Speaker hanging and mounting hardware must be supplied by an approved rigging hardware manufacturer and/or the loudspeaker manufacturer.
 - f. All rigging and related fastening methods must be treated as permanent. All threads must be treated with vibration compounds per manufacturer's recommendations.
 - g. All rigging hardware must be load rated, with the load rating or approval stamped on each piece of hardware.
 - h. Chain of any type, plastic or fabric will not be acceptable for the hanging or backup support of any equipment.
 - i. Stainless steel rope shall not be secured with threaded compression type fittings alone. Compression type closures such as Nicopress shall be utilized. Each closure must have a backup closure. All wire rope shall have strain relief thimbles installed. Neatly tape down all loose ends after Nicopress is installed and crimped.
 - j. Contractor shall have personnel properly trained to install rigging. Documentation must be supplied to verify proper training.
2. Audio Equipment Cabinets: Coordinate with Architect and Owner exact location of equipment cabinets and exact location of conduit systems and AC receptacles required.
 3. Supply, install and terminate, all low voltage wire and connections to all speakers, audio input and output plates, boxes, racks and panels.
 4. Provide cable requirements and specifications.
 5. Provide cable ID information to affix to pulled wires and cables.
 6. Provide and install final permanent labels to each termination upon completion of installation.
 7. Provide all mounting brackets, rigging and hardware for speakers and install all support assemblies.
 - a. All structural members and attachment mounting plates in walls and ceilings.
 8. Drawings are diagrammatic and indicate general arrangement of systems and work included. Follow drawings in laying out work and check drawings of other trades relating to work to verify spaces in which work will be installed. Maintain headroom and space conditions to all points.

9. Final location of all equipment shall be as shown on approved shop drawings, or as located in the field by the Architect.

3.3 FIELD QUALITY CONTROL

A. System Performance Tests and Adjustments:

1. Test Equipment:

- a. Provide following test equipment for initial test and adjustments and during acceptance testing and final adjustments to system: ANSI standard audio level meter, calibrated test microphone, sine wave generator, pink noise generator, A.C. impedance bridge, audio oscilloscope, 1/3 octave real-time spectrum analyzer, reverberation time analyzer, RMS-responding voltmeter, phase checker, graphic level recorder, and connecting cables sufficient to terminate test equipment to system.
- b. Provide suitable portable mounting surface for temporary set up of test equipment.
- c. Provide test equipment manufactured by Bruel & Kjaer, GenRad, Hewlett-Packard, Fluke, Tektronix, Ivie, and similar manufacturers. Non-professional equipment and shop-assembled it's are not acceptable.
- d. Set initial adjustments of loudspeakers, equalizers and other signal processing equipment. Make final adjustments to these items if so directed. Assist as requested in confirming that performance requirements are met. Provide additional field assembled resistive pads and/or resistor-capacitor networks as requested.
- e. Execute moderate moves or changes necessary to accommodate other equipment or preserve symmetry and pleasing appearance without claim for additional payment.

2. Shop Tests:

- a. Measure to confirm each components conformance with its manufacturer=s published specifications for functional capabilities and control, electrical gain, self-generated noise, frequency response, distortion, and freedom from RFI, EMI and other interference. Rectify any defects and record the final measurements.
- b. Test all rack-assembled subsystems and all fabricated subassemblies for proper function and performance levels. Rectify any defects.
- c. Measure impedance of each loudspeaker assembly at 63, 250, 1000, 4000 and 16000 Hz, excluding any measurements that fall Contractorde assemblies' nominal operating frequency bandwidth. Reject and replace any assembly measuring below 80 percent of its nominally rated impedance.

B. Initial Post-Completion Tests and Adjustments

1. Loudspeaker Line Impedance: Disconnect loudspeaker lines from their amplifiers. Measure resistance and impedance of each loudspeaker line leaving equipment rack at center of load's passband or at least one octave removed from crossover frequency. Verify that values are within +/- 10 percent of value calculated for that circuit based upon parallel impedances of loudspeakers connected plus the resistance of loudspeaker line. Correct any discrepancies and record final measurements.
2. Loudspeaker Polarity:
 - a. Inspect loudspeaker line polarities with phase checker or with multi-meter and DC signal source. Polarize all loudspeaker lines identically with respect to color-coding.
 - b. Inspect high frequency loudspeaker polarities with respect to one another with phase checker and bring all units into common polarity. Confirm appropriateness of polarization through listening tests using speech and music program material. Move slowly from coverage of one high frequency loudspeaker to next with loudspeakers connected in and out of polarity. No degradation of program material should be heard in overlap zone with loudspeakers in proper polarity. Similarly inspect and set polarities of high frequency and low frequency loudspeakers, reversing polarity and one frequency range to confirm initial observations. Restore initial polarities as appropriate.
3. Field Wiring Integrity: Measure DC resistance of all microphone field input lines, measuring each conductor pair and each conductor/shield pair both open and shorted. Measure resistance of each conductor and shield with reference to building ground to confirm open circuits. Correct any shorts, erroneous opens, or unusual resistances. Record final measurements.
4. Hum and Noise Level: Disconnect loudspeaker lines from amplifier outputs and power resistors matching amplifiers' rated load impedance and output power. Adjust system's gain controls for optimum signal-to-noise ratio and for full amplifier outputs with +4 dBm amplifier input signals. Terminate system inputs with shielded 600-ohm resistors and measure hum and noise levels of overall system. Record measurements.
5. Power Output and Distortion: Adjust gain controls as for hum and noise tests, set equalization for flat response and terminate amplifier outputs with power resistors having values equal to nominal impedance of assigned loudspeaker lines. Apply 1,000 Hz sine wave signal to selected system input at level required to produce full amplifier outputs. Use distortion analyzer to measure output level and total harmonic distortion of system from all rack inputs through all amplifier outputs. Record final measurements.
6. Parasitic Oscillation and RF Pickup: Inspect system using oscilloscope for freedom from spurious oscillation and radio frequency pick up, both in absence of any audio input signal and also with system driven to full output at 100 Hz. Record the findings.

7. Equalization: Measure system acoustical performance using calibrated ANSI standard type 1 or IEC precision audio level meter set for “slow” meter damping except as otherwise noted, and flat response with random incidence at 4 to 5 feet height. Ensure all interior finishes and furnishings are in place, and system gain is adjusted to provide levels of 70 to 80 dB and at least 10 dB above background noise at measuring locations for these tests, except as otherwise noted. Response curves directly recorded from calibrated real time analyzer. Point-by-point measurements, averaging estimates, and other non-real-time dynamic measurements not acceptable. Include following tests and adjustments in equalization process:
8. House Curve Equalization: Measure loudspeaker frequency response with all control equalization set for flat response, using 1/3 octave bands of filtered pink noise centered on ANSI preferred frequencies, or broadband calibrated pink noise measured in 1/3 octave bands using calibrated real time analyzer. Record acoustic amplitude response appearing on real time analyzer screen. Point-by-point measurements, averaging estimates, and other non-real time dynamic measurements not acceptable. After recording un-equalized acoustic amplitude response, adjust equalization to bring observed acoustic amplitude within +/- 1 dB uniformity and to conform to predetermined high frequency roll-off dictated by combined effects of humidity, air absorption, and random incidence of measuring microphone. Once this response is attained, record acoustic response of system and record electrical response of equalizer used to achieve this response. Document control settings used to achieve this response.
9. Feedback Corrections: Connect microphone into audio system, and place in normal operating position closet to loudspeaker system. Adjust audio system gain until it reaches regeneration (feedback). Determine frequency of regeneration by observing response of real time audio spectrum analyzer and adjust appropriate filter until observed regeneration ceases. Continue procedure until the required potential acoustic gain (PAG) is achieved. Record resulting acoustic response of audio system and record electrical response of equalizer. Document control settings used to achieve this response.
10. Proximity Stability: Suppress tendency of audio system microphone to become unstable when approached by talker. Identify 1/3 octave band affected by approach of a person and provide enough attenuation to ensure stability. Record resulting acoustic response of audio system and record electrical response of equalizer. Document control settings used to achieve this response.
11. Uniformity of Coverage: Measure and record acoustic distribution of loudspeakers in audio system throughout entire seating area. Record location of all positions in seating and where any 1/3-octave band from 250 to 5000 Hz, deviates more than +/- 3 dB from desired curve.
12. Maximum Output Level: Measure and record maximum output level of system, using standard “fast” meter damping and employing wideband-recorded music at test signal. System should be capable of providing 90 dB SPL in audience area on axis of any high frequency loudspeaker.

13. Buzzes, Rattles and Other Noises: Apply slow, sinewave sweep from 50 to 5000 Hz at level to produce amplifier outputs to 6 dB below their nominal ratings. Listen carefully for buzzes, rattles and other noises. Correct all defects in system. Advise of any noises that are clearly external to system.
14. Gain Control Settings: Establish tentative normal settings for all gain controls after adjusting all gain controls for optimum signal-to-noise ration and signal balance. Record settings.
15. Freedom from Switching Transient Noise: Eliminate audible clicks or pops produced by operation of any controls.
16. Listening Test: Listen to normal program material, including both speech and music, at both normal and at maximum volume levels to be sure that there are no remaining defects.
17. Test Report and Certificates: Submit 2 copies of test results, including numerical values, upon completion of initial test and adjustments. Include written certification that installation conforms to requirements of specifications, that it is complete in all respects, and that it is ready for demonstration and acceptance testing.

C. Demonstration And Acceptance Testing

1. Demonstration: Demonstrate operation of each major component and of complete installation following approval of test report and at time mutually agreed upon by Architect/Engineer, Owner's representative, and contractor responsible for installation of audio system.
2. Acceptance Tests: Assist as required during acceptance tests and adjustments that follow demonstration. Provide all labor, materials, tools, and measurement equipment necessary for those tests and adjustments, except as otherwise specified. Ensure contractor's representative assisting in performance of these tests is thoroughly familiar with all details of system and include field supervisor in overall charge during course of installation work. Budget 16 working hours (not inclusive of travel time) for performance of these tests and adjustments. If final acceptance is delayed beyond this period because installation is not in accordance with specified requirements, pay for all additional time and expenses of Architect/Engineer and Owner's representative during any resultant extension of acceptance testing period.
3. Listening Tests: Assist subjective evaluation of system by observers listening at various positions under various operating conditions, using speech, music, and live or recorded materials.

4. Equipment Tests: Perform any measurements of frequency response, distortion, noise of other characteristics and any operation tests deemed necessary by Architect/Engineer or Owner's representative to determine conformance of system and its installation with specified requirements. Make any adjustments to system or its installation required to ensure system operates properly as directed by Architect/Engineer or Owner's representative. This may include, but is not limited to, changes to equalization or level balance, and changes to or installation of resistive pads and RC networks. Record final control settings and final values of any installed components.
5. Digital Signal Transport System
 - a. Verify number of HDCP keys supported by each source device.
 - b. Video timing and support audio formats (if applicable) for each display device.
 - c. Video timing and supported audio formats presented in the EDID for each source. Indicate preferred video timing.
 - d. Length of installed twisted pair cables used for signal distribution and control.
6. Projection
 - a. Employ an RGB test generator to produce signals with horizontal scan frequencies of 15.75 kHz, 35 kHz, 64 kHz and other frequencies as directed.
 - b. Test as specified by manufacturer.
7. Subjective Image Quality
 - a. Observe the image quality on various displays throughout the system, employing various sources such as workstations and videotape, and check for errors of linearity, chroma-luminance delay, signal to noise performance, blanking and gain shifts, RF interference, crosstalk, and other imperfections. Test for these errors under various operating conditions, including selecting random sources into selected projectors.
8. Control System
 - a. Verify that all devices being controlled by the master control system respond to corresponding graphic elements on touch screens. Check all screens for full functionality. Test touch panels at all connection locations.
9. Category Cabling
 - a. Verify that all jacks have been terminated properly and conform to ANSI/TIA/EIA-568-C.
 - 1) Provide list of cable runs each with associated bandwidth and length information, as well as pass/fail for ANSI/TIA/EIA-568-C compliance.

3.4 SYSTEM PRESETS

- A. Provide loudspeaker presets per Owner's direction.

3.5 GROUNDING

- A. Microphone line shields shall be grounded only at the equipment rack(s) and shall be grounded only to the common ground of the equipment rack.
- B. All audio grounds in the equipment rack(s) shall be electrically grounded to the isolated ground buss bar mounted in each rack.
- C. Bus bars in each rack then shall be grounded to a single point at the isolated ground panel buss bar.
- D. Total resistance of the ground system from racks to the building ground shall not exceed .1 ohm.
- E. Other shields shall be grounded only at the power amplifier inputs or the console outputs and shall be terminated at the “floating” end with “wedge on” collars, or with plastic tape. Continuity of shield shall be preserved at connecting points.
- F. Patch panels shall be wired so all signal sources (outputs from equipment), shall be connected to the top row. Any efficient combination of top and bottom rows shall be used for multiples.

3.6 DEMONSTRATION

- A. Refer to SECTION 26 05 00 – Common Work Results for Electrical (Paragraph 3.2 – Demonstration of Complete Electrical Systems) for additional requirements.
- B. Training: In addition to demonstration specified above in “Demonstration and Acceptance Testing” Prime Contractor shall provide (8)-hour training sessions by experienced audio engineer over 6- month intervals, covering miking techniques for vocals and various instruments, operation of mixer, equalizer and amplifiers, and general system maintenance requirements and techniques. Training shall be conducted in (2) hours block with scheduling determined by the Owner. Training time shall not include travel time.
- C. Provide up to (8) hours support to tune the audio system after training is complete.
- D. Provide a shortcut manual (graphic documentation) indicating the position of all system settings to achieve owner-designated configurations (i.e., speech reinforcement during events, program material, etc.).

3.7 CLOSEOUT DOCUMENTATION

- A. Provide (7) copies of all of the following:
 - 1. System manual (bound) containing the following items:
 - 2. Table of contents.
 - 3. Specification sheets and technical manuals for all equipment.
 - 4. Maintenance procedures for all installed equipment.
 - 5. Color-coded wiring diagrams, indicating all wiring types, connections and paths.
 - 6. 30 in. by 42 in. as-built drawings indicating location of all equipment and wiring, color-coded to match installation.

7. Shortcut tuning documentation as described under Training.
8. List of serial numbers of all equipment installed.
9. Copies of warranty cards for all equipment.
10. List of frequencies used for wireless equipment and copies of licenses.
11. Lists of consumable items and replacement parts for routine maintenance (fuses, etc.)
12. Copy of the software presets and any operating software.

3.8 FIELD QUALITY CONTROL

- A. Submit written test report from authorized representative of equipment manufacturer that system has been tested and is in working order prior to final inspection by Architect/Engineer.

END OF SECTION 27 51 25

SECTION 28 31 11 - DIGITAL, ADDRESSABLE FIRE-ALARM AND VOICE NOTIFICATION SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Scope:

- 1. At the LaGrange Middle School, remove all existing fire alarm devices and all associated wiring to the existing addressable FACP, remove addressable FACP in its entirety. Provide an addressable fire alarm/voice notification (FAVN) control panel, devices as shown on drawings and all wiring. Provide programming for all devices.

- B. Section Includes:

- 1. Fire-alarm/voice notification control panel.
 - 2. Manual fire-alarm boxes.
 - 3. System smoke detectors.
 - 4. Heat detectors.
 - 5. Notification appliances.
 - 6. Magnetic door holders.
 - 7. Remote annunciator panel.
 - 8. Graphic display.
 - 9. Addressable interface devices.
 - 10. Digital alarm communicating transmitter (DACT).

1.3 REFERENCES

- A. Comply with New York State Uniform Fire Prevention & Building Code.
- B. Comply with U.S. Department of Justice – American Disabilities Act.
- C. Acoustical Society of America (ASA)
 - 1. ASA S3.2 Method for Measuring the Intelligibility of Speech Over Communications Systems.
- D. National Fire Protection Association Standards:
 - 1. NFPA 70 - National Electrical Code.

2. NFPA 72 - National Fire Alarm Code.
 3. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
- E. Provide system and components listed by Underwriters Laboratories Inc. (UL) for use in fire protective signaling system under following standards as applicable:
1. UL 864 - UOJZ, APOU Control Units for Fire Protective Signaling Systems.
 2. UL 268 - Smoke Detectors for Fire Protective Signaling Systems.
 3. UL 268A - Smoke Detectors for Duct Applications.
 4. UL 521 - Heat Detectors for Fire Protective Signaling Systems.
 5. UL 228 - Door Holders for Fire Protective Signaling Systems.
 6. UL 464 - Audible Signaling Appliances.
 7. UL 1971 - Visual Signaling Appliances.
 8. UL 38 - Manually Activated Signaling Boxes.
 9. UL 1481 - Power Supplies for Fire Protective Signaling Systems.

1.4 DEFINITIONS

- A. LED: Light-emitting diode.
- B. NICET: National Institute for Certification in Engineering Technologies.
- C. LOC: Local Operating Console.
- D. VNS: Voice Notification System.

1.5 SYSTEM DESCRIPTION

- A. Non-coded, UL-certified addressable system, with automatic sensitivity control of certain smoke detectors and multiplexed signal transmission, dedicated to fire-alarm service only.
- B. This work includes completion of design and providing a new, complete, fire alarm and voice notification system as described herein and on the contract drawings. Include in the system wiring, raceways, pull boxes, terminal cabinets, outlet and mounting boxes, control equipment, alarm, and supervisory signal initiating devices, alarm notification appliances, supervising station fire alarm system transmitter, and other accessories and miscellaneous items required for a complete operating system even though each item is not specifically mentioned or described. Provide a system complete and ready for operation.
- C. Provide equipment, materials, installation, inspection, and testing in strict accordance with the required and advisory provisions of NFPA 70, NFPA 72, except as modified herein. The system layout on the drawings shows the intent of coverage and are shown in suggested locations. Submit plan view drawing showing device locations, terminal cabinet locations, junction boxes, other related equipment, conduit routing, wire counts, circuit identification in each conduit, and circuit layouts for all floors. Drawings shall comply with the requirements of NFPA 170. Final quantity, system layout, and coordination are the responsibility of the Contractor
- D. Provide Common Intelligibility Scale (CIS) and sound pressure level calculations with the shop drawing submittal to confirm that intelligibility requirements will be met. CIS calculations shall be done with computer software intended for that purpose.

1.6 SUBMITTALS

A. General Submittal Requirements:

1. Shop Drawings shall be prepared by persons with the following qualifications:

- a. Trained and certified by manufacturer in fire-alarm system design.
- b. NICET-certified fire-alarm technician, Level IV minimum.

B. Product Data: Submit manufacturer's documentation for all components of proposed fire alarm system required to demonstrate compliance with specified requirements, including (but not limited to) type, size rating, style, catalog number, manufacturer name, photographs, and catalog data sheet for each component.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
2. Include voltage drop calculations for notification appliance circuits with the system operating on battery power, with battery voltage to the system at 20 volts.
3. Include battery-size calculations.
4. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
5. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.
6. Include complete one-line riser diagrams showing all equipment locations and sizes, and point-by-point wiring diagram with type and number of all conductors.
7. Submit detailed drawing of FAVN Panel(s) including all module/component locations and panel point-to-point wiring diagrams including all field circuit termination points.
8. Submit floor plan layout of Graphic Display Panel indicating building zones, room numbers, and "You Are Here" location. Orient building floor plan on graphic to the location of person viewing the installed Graphic Display Panel, i.e. the direction the viewer is facing shall be toward the top of the graphic display.

D. Technical Data and Computer Software

1. Technical data and computer software (meaning technical data that relates to computer software) that are specifically identified in this project, and may be defined/required in other specifications, shall be delivered, strictly in accordance with the CONTRACT CLAUSES. Identify data delivered by reference to the particular specification paragraph against which it is furnished. Data to be submitted shall include complete system, equipment, and software descriptions. Descriptions shall show how the equipment will operate as a system to meet the performance requirements of this contract. The data package shall also include the following:
 - a. Identification of programmable portions of system equipment and capabilities.
 - b. Description of system revision and expansion capabilities and methods of implementation detailing both equipment and software requirements.
 - c. Provision of operational software data on all modes of programmable portions of the fire alarm and voice notification system.
 - d. Description of fire alarm and voice notification control panel equipment operation.
 - e. Description of auxiliary and remote equipment operations.
 - f. Library of application software.
 - g. Operation and maintenance manuals.

E. Qualification Data:

1. Supervisor:
 - a. NICET Fire Alarm Technicians to perform the installation of the system. A NICET Level 4 Fire Alarm Technician shall supervise the installation of the fire alarm system/voice notification system. A Fire Alarm Technician with a minimum of 8 years of experience shall perform/supervise the installation of the fire alarm/voice notification system. The Fire Alarm technicians supervising the installation of equipment shall be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.
2. Technician:
 - a. NICET Level III Fire Alarm Technicians with a minimum of four years of experience utilized to install and terminate fire alarm/voice notification devices, cabinets and panels. The Fire Alarm technicians installing the equipment shall be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.
3. Installer:
 - a. Fire Alarm installer with a minimum of two years of experience utilized to assist in the installation of fire alarm/voice notification devices, cabinets and panels. A NICET Level II technician to assist in the installation of fire alarm/voice notification devices, cabinets and panels. An electrician shall be allowed to install wire, cable, conduit and backboxes for the fire alarm system/voice notification system. The Fire Alarm installer shall be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

4. Test Personnel:

- a. Fire Alarm Technicians with a minimum of eight years of experience (NICET Level III) utilized to test and certify the installation of the fire alarm/voice notification devices, cabinets and panels. The Fire Alarm technicians testing the equipment shall be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

5. Manufacturer's Representative:

- a. The fire alarm and voice notification equipment manufacturer's representative shall be present for the connection of wiring to the control panel. The Manufacturer's Representative shall be an employee of the manufacturer with necessary technical training (NICET Level III or[, IV]) on the system being installed.

6. Manufacturer:

- a. Components shall be of current design and shall be in regular and recurrent production at the time of installation. Provide design, materials, and devices for a protected premises fire alarm system, complete, conforming to NFPA 72, except as otherwise or additionally specified herein.

F. Regulatory Requirements

1. Requirements for Fire Protection Service:

- a. Equipment and material shall have been tested by UL and listed in UL Fire Prot Dir or approved by FM and listed in FM APP GUIDE. Where the terms "listed" or "approved" appear in this specification, they shall mean listed in UL Fire Prot Dir or FM APP GUIDE. The omission of these terms under the description of any item of equipment described shall not be construed as waiving this requirement. All listings or approval by testing laboratories shall be from an existing ANSI or UL published standard.

2. Fire Alarm/Voice Notification System:

- a. Furnish equipment that is compatible and is UL listed, FM approved, or listed by a nationally recognized testing laboratory for the intended use. All listings by testing laboratories shall be from an existing ANSI or UL published standard. Submit a unique identifier for each device, including the control panel and initiating and indicating devices, with an indication of test results, and signature of the factory-trained technician of the control panel manufacturer and equipment installer. With reports on preliminary tests, include printer information. Include the NFPA 72 Record of Completion and NFPA 72 Inspection and Testing Form, with the appropriate test reports.

3. Fire alarm Testing Services or Laboratories:

- a. Construct fire alarm and fire detection equipment in accordance with UL Fire Protection Dir, UL Electrical Construction, or FM APP GUIDE.

4. Contractor performing fire alarm system work shall be a licensed fire alarm contractor. Contractor shall provide Fire Alarm Installation Certification with fire alarm system submittal.
- G. Field quality-control reports.
- H. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
 2. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
 3. Record copy of site-specific software.
 4. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:
 - a. Frequency of testing of installed components.
 - b. Frequency of inspection of installed components.
 - c. Requirements and recommendations related to results of maintenance.
 - d. Manufacturer's user training manuals.
 5. Manufacturer's required maintenance related to system warranty requirements.
 6. Abbreviated operating instructions for mounting at fire-alarm control panel.
 7. Copy of NFPA 25.

1.7 QUALITY ASSURANCE

- A. Source Limitations for Fire-Alarm/Voice Notification System and Components: Obtain fire-alarm/Voice Notification system from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. NFPA Certification: Obtain certification according to NFPA 72 by a Nationally Recognized Testing Laboratory (NRTL).

1.8 PROJECT CONDITIONS

- A. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:

1. Coordinate and comply with the requirements of the local Fire Marshall, or Authority Having Jurisdiction, concerning the fire alarm system shutdown plans, procedures, and fire watch plans that will be implemented for system interruptions during construction. All existing fire alarm devices shall remain active until new cabling and devices are installed. Temporary interruptions are allowed while work is being done on the system. Work shall be coordinated so that system is fully functional at the end of the workday. If system is not fully functional at end of workday, Contractor shall provide personnel for fire watch as required by local Fire Marshall and shall be responsible for all associated costs.
2. Notify Construction Manager and Owner no fewer than two days in advance of proposed interruption of fire-alarm service.
3. Do not proceed with interruption of fire-alarm service without Construction Manager and Owner's written permission.

1.9 SEQUENCING AND SCHEDULING

- A. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service and label existing fire-alarm equipment "NOT IN SERVICE" until removed from the building. Coordinate and comply with the requirements of the local Fire Marshall, or Authority Having Jurisdiction, concerning the fire alarm system shutdown plans, procedures, and fire watch plans that will be implemented for system interruptions during construction.
- B. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

1.10 SOFTWARE SERVICE AGREEMENT

- A. Comply with UL 864.
- B. Technical Support: Beginning with Substantial Completion, provide software support for two years.
- C. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
 1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

1.11 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps for Remote Indicating Lamp Units: Quantity equal to 5 percent of amount installed, but no fewer than 2 units.
2. Strobe Units: Quantity equal to 5 percent of amount installed, but no fewer than 2 units.
3. Smoke Detectors and Heat Detectors: Quantity equal to 5 percent of amount of each type installed, but no fewer than 2 units of each type.
4. Detector Bases: Quantity equal to 2 percent of amount of each type installed, but no fewer than 2 units of each type.
5. Keys and Tools: One extra set for access to locked and tamper proofed components.
6. Audible and Visual Notification Appliances: Quantity equal to 5 percent of amount installed, but no fewer than 2 units.
7. Fuses: Five of each type installed in the system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. NOTIFIER; a Honeywell company.
 2. Siemens Building Technologies, Inc.; Fire Safety Division.
 3. SimplexGrinnell LP; a Tyco International company.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

- A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:
1. Manual stations.
 2. Heat detectors.
 3. Smoke detectors.
 4. Duct smoke detectors.
 5. Verified automatic alarm operation of smoke detectors
 6. CO detectors.
 7. Automatic sprinkler system water flow.
 8. Fire-extinguishing system operation.
 9. Fire standpipe system.
- B. Fire-alarm signal shall initiate the following actions:
1. Continuously operate alarm/voice notification appliances.
 2. Identify alarm at fire-alarm control panel and remote annunciators.
 3. Transmit an alarm signal to the remote alarm receiving station.
 4. Release fire and smoke doors held open by magnetic door holders.
 5. Shut down heating, ventilating, and air-conditioning equipment.
 6. Close smoke dampers in air ducts of designated air-conditioning duct systems.
 7. Activate emergency shutoffs for gas and fuel supplies.
 8. Record events in the system memory.

- C. Supervisory signal initiation shall be by one or more of the following devices and actions:
 - 1. Valve supervisory switch.
 - 2. Low-air-pressure switch of a dry-pipe sprinkler system.
 - 3. Elevator shunt-trip supervision.
- D. System trouble signal initiation shall be by one or more of the following devices and actions:
 - 1. Open circuits, shorts, and grounds in designated circuits.
 - 2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
 - 3. Loss of primary power at fire-alarm/voice notification control panel.
 - 4. Ground or a single break in fire-alarm control panel internal circuits.
 - 5. Abnormal ac voltage at fire-alarm control panel.
 - 6. Break in standby battery circuitry.
 - 7. Failure of battery charging.
 - 8. Abnormal position of any switch at fire-alarm/voice notification control panel or annunciator.
 - 9. Low-air-pressure switch operation on a dry-pipe or pre-action sprinkler system.
- E. System Trouble and Supervisory Signal Actions: Annunciate at fire-alarm/voice notification control panel and remote annunciators.

2.3 FIRE-ALARM/VOICE NOTIFICATION CONTROL PANEL

- A. General Requirements for Fire-Alarm/Voice Notification Control Panel:
 - 1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864 and listed and labeled by an NRTL.
 - a. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
 - b. Include a real-time clock for time annotation of events on the event recorder and printer.
 - 2. Addressable interface devices that communicate device identity and status.
 - a. Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at fire-alarm control panel.
 - b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.
 - 3. Addressable interface devices for operation of mechanical equipment.
- B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control panel and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, 3 line(s) of 80 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.

C. Circuits:

1. Signal Line Circuits and Notification Appliance Circuits: NFPA 72-2010, Class B.
2. Install no more than 100 addressable devices on each signal line circuit.
3. Connect Notification Appliance Circuits so that signaling circuit or power supply output does not exceed 70 percent of rated capacity. Provide circuits with appropriately sized cable, sized per 100 percent of power supply output, in accordance with manufacturer's requirements.
4. Wire and control the Notification Appliance Circuits such that the audible alarm indicating devices can be turned off while the visual alarm notifications remain operational.

D. Amplifiers, Preamplifiers, Tone Generators

1. Any amplifiers, preamplifiers, tone generators, digitalized voice generators, and other hardware necessary for a complete, operational, textual audible circuit conforming to NFPA 72 shall be housed in a remote FVCP, terminal cabinet, or in the FVCP. Submit data to indicate that the amplifiers have sufficient capacity to simultaneously drive all notification speakers at the maximum rating plus 50 percent spare capacity. Annotate data for each circuit on the drawings.
2. Operation - The system shall automatically operate and control all building speakers except those installed in the stairs and within elevator cabs. The speakers in the stairs and elevator cabs shall operate only when the microphone is used to deliver live messages.
3. Construction - Amplifiers shall utilize computer grade solid state components and shall be provided with output protection devices sufficient to protect the amplifier against any transient up to 10 times the highest rated voltage in the system.
4. Inputs - Equip each system with separate inputs for the tone generator, digitalized voice driver and panel mounted microphone and [Public Address Paging Function (where allowed)]. Microphone inputs shall be of the low impedance, balanced line type. Both microphone and tone generator input shall be operational on any amplifier.
5. Tone Generator - The tone generator shall be of the modular, plug-in type with securely attached labels to identify the component as a tone generator and to identify the specific tone it produces. The tone generator shall produce a code 3 temporal tone and shall be constantly repeated until interrupted by either the digitalized voice message, the microphone input, or the alarm silence mode as specified. The tone generator shall be single channel with an automatic backup generator per channel such that failure of the primary tone generator causes the backup generator to automatically take over the functions of the failed unit and also causes transfer of the common trouble relay.

6. Protection Circuits - Each amplifier shall be constantly supervised for any condition that could render the amplifier inoperable at its maximum output. Failure of any component shall cause automatic transfer to a designated backup amplifier, illumination of a visual "amplifier trouble" indicator on the control panel, appropriate logging of the condition on the system printer, and other actions for trouble conditions as specified.

E. Smoke-Alarm Verification:

1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control panel.
2. Activate an NRTL-listed and -approved "alarm-verification" sequence at fire-alarm control panel and detector.
3. Record events by the system log.
4. Sound general alarm if the alarm is verified.
5. Cancel fire-alarm control panel indication and system reset if the alarm is not verified.

F. Notification Appliance System:

1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
2. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.
3. The Audible Notification System shall comply with the requirements of NFPA 72 for Emergency Voice/Alarm Communications System requirements except as specified herein.
4. The system shall be a one-way multi-channel voice notification system incorporating user selectability of a minimum eight distinct sounds for tone signaling, and the incorporation of a voice module for delivery of prerecorded messages. Audible appliances shall produce a temporal code
5. 3 tone for three cycles followed by a voice message that is repeated until the control panel is reset or silenced. Automatic messages shall be broadcast through speakers throughout the building/facility but not in stairs or elevator cabs. A live voice message shall override the automatic audible output through use of a fire fighter microphone input at a remote control panel.
 - a. When using the microphone, live messages shall be broadcast throughout a selected floor or floors or all call. The system shall be capable of operating all speakers at the same time. The microprocessor shall actively interrogate circuitry, field wiring, and digital coding necessary for the immediate and accurate rebroadcasting of the stored voice data into the appropriate amplifier input. Loss of operating power, supervisory power, or any other malfunction that could render the digitalized voice module inoperative shall automatically cause the code 3 temporal tone to take over all functions assigned to the failed unit in the event an alarm is activated.

- b. The Voice Notification functions shall override the manual or automatic fire alarm notification function. Other fire alarm functions including transmission of a signal(s) to the fire department shall remain operational. Notification Appliance Circuits (NAC) shall be provided for the activation of strobe appliances. The activation of the NAC Circuits shall follow the operation of the speaker NAC circuits. Audio output shall be selectable for line level. Amplifier outputs shall be not greater than 100 watts RMS output. The strobe NAC Circuits shall provide at least 2 amps of 24 VDC power to operate strobes and have the ability to synchronize all strobes. fire fighter hand held microphone shall be provided and, upon activation, shall take priority over any tone signal or recorded message in progress, while maintaining the strobe NAC Circuits activation.

G. Outputs and Operational Modules

- 1. All outputs and operational modules shall be fully supervised with on-board diagnostics and trouble reporting circuits. Provide form "C" contacts for system alarm and trouble conditions. Provide circuits for operation of auxiliary appliance during trouble conditions. During a Voice Notification event, the panel shall not generate nor cause any trouble alarms to be generated with the Fire Alarm system.

H. Voice Notification functions shall take precedence over all other function performed by the Audible Notification System. Messages shall utilize a male voice and shall be similar to the following:

- 1. 1000 Hz tones (as required in 18.4.2.1 of NFPA 72)
- 2. "May I have your attention please. May I have your attention please. A fire emergency has been reported in the building. Please leave the building by the nearest exit or exit stairway. Do not use the elevators." (Provide a 2 second pause.) "May I have your attention please, (repeat the message)."

I. Elevator Recall:

- 1. Smoke detectors at the following locations shall initiate automatic elevator recall. Alarm-initiating devices, except those listed, shall not start elevator recall.
 - a. Elevator lobby detectors except the lobby detector on the designated floor.
 - b. Smoke detector in elevator machine room.
 - c. Smoke detectors in elevator hoistway.
- 2. Elevator lobby detectors located on the designated recall floors shall be programmed to move the cars to the alternate recall floor.
- 3. Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.
 - a. Water-flow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated floor.

- J. Door Controls: Door hold-open devices at doors in smoke barrier walls shall be connected to fire-alarm system to disconnect power to closures upon any alarm.
- K. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory.
- L. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station via a Digital Alarm Communicating Transmitter (DACT).
- M. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory signals supervisory and digital alarm communicator transmitters shall be powered by 24-V dc source.
 - 1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.
- N. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
 - 1. Batteries: Sealed, valve-regulated, recombinant lead acid.
- O. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.4 MANUAL FIRE-ALARM BOXES

- A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
 - 1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control panel.
 - 2. Station Reset: Key- or wrench-operated switch.
 - 3. Indoor Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm at locations where indicated.

2.5 SMOKE DETECTORS

A. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.
2. Detectors shall be two-wire type.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control panel.
4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status.
7. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at fire-alarm control panel for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control panel.
 - a. Rate-of-rise temperature characteristic shall be selectable at fire-alarm control panel for 15 or 20 deg F (8 or 11 deg C) per minute.
 - b. Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control panel to operate at 135 or 155 deg F (57 or 68 deg C).
 - c. Provide multiple levels of detection sensitivity for each sensor.

B. Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire-alarm control panel and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control panel, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).

C. Duct Smoke Detectors: Photoelectric type complying with UL 268A.

1. Detector address shall be accessible from fire-alarm control panel and shall be able to identify the detector's location within the system and its sensitivity setting.

2. An operator at fire-alarm control panel, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).
3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.
4. Each sensor shall have multiple levels of detection sensitivity.
5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
6. Addressable Interface Device Fan Shutdown Relay: Rated to interrupt fan motor-control circuit.

2.6 HEAT DETECTORS

- A. General Requirements for Heat Detectors: Comply with UL 521.
- B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F (57 deg C) or a rate of rise that exceeds 15 deg F (8 deg C) per minute unless otherwise indicated.
 1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control panel.
- C. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F (88 deg C).
 1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control panel.

2.7 PROJECTED BEAM SMOKE DETECTORS

- A. Projected Beam Light Source and Receiver: Designed to accommodate small angular movements and continue to operate and not cause nuisance alarms.
- B. Detector Address: Accessible from fire-alarm control unit and able to identify the detector's location within the system and its sensitivity setting.
- C. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 1. Primary status.
 2. Device type.

3. Present average value.
4. Present sensitivity selected.
5. Sensor range (normal, dirty, etc.).

2.8 CARBON MONOXIDE DETECTORS

- A. General: Carbon monoxide detector listed for connection to fire-alarm system.
 1. Mounting: Adapter plate for outlet box mounting.
 2. Testable by introducing test carbon monoxide into the sensing cell.
 3. Detector shall provide alarm contacts and trouble contacts.
 4. Detector shall send trouble alarm when nearing end-of-life, power supply problems, or internal faults.
 5. Comply with UL 2075.
 6. Locate, mount, and wire according to manufacturer's written instructions.
 7. Provide means for addressable connection to fire-alarm system.
- B. Test button simulates an alarm condition

2.9 ADDRESSABLE INTERFACE DEVICES

- A. Microelectronic monitor module, NRTL listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts.
- B. Microelectronic relay module: Relay shall have form C dry contacts. NRTL listed for use in providing a system address for providing a signal to:
 1. Air handling units to initiate fan shutdown.
 2. Elevator controller to initiate elevator recall.
 3. Circuit-breaker shunt trip for power shutdown.

2.10 NOTIFICATION APPLIANCES

- A. Fire Alarm/Voice Notification Speakers
 1. Audible appliances shall conform to the applicable requirements of UL 464. Appliances shall be connected into notification appliance circuits. Surface mounted audible appliances shall be factory painted red.
 - a. Speakers shall conform to the applicable requirements of UL 1480. Speakers shall have six different sound output levels and operate with audio line input levels of 70.7 VRMs and 25 VRMs, by means of selectable tap settings. Tap settings shall include taps of 1/8, 1/4, 1/2, 1, and 2 watts. Speakers shall incorporate a high efficiency speaker for maximum output at minimum power across a frequency range of 150 Hz to 10,000 Hz, and shall have a sealed back construction. Speakers shall be capable of installation on standard 100 mm square electrical boxes. Where speakers and strobes are provided in the same location, they may be combined into a single wall or ceiling mounted unit. All inputs shall be polarized for compatibility with standard reverse polarity supervision of circuit wiring via the FAVN panel.

- b. Provide speaker mounting plates constructed of cold rolled steel having a minimum thickness of 1.519 mm (16 gauge) or molded high impact plastic and equipped with mounting holes and other openings as needed for a complete installation. Fabrication marks and holes shall be ground and finished to provide a smooth and neat appearance for each plate. Each plate shall be primed and painted.
- c. Speakers shall utilize screw terminals for termination of all field wiring.

B. Visual Notification Appliances

- 1. Visual notification appliances shall conform to the applicable requirements of UL 1971 and conform to the Architectural Barriers Act (ABA). The lens of the fire alarm strobe shall be located such that the entire lens is located not less than 80 inches and not more than 96 inches above the finished floor. Fire Alarm Notification Appliances shall have clear high intensity optic lens, xenon flash tubes, and be marked "Fire" in red letters. The light pattern shall be disbursed so that it is visible above and below the strobe and from a 90 degree angle on both sides of the strobe. Strobe flash rate shall be 1 flash per second and a minimum of 15 candela, Strobe shall be surface mounted to masonry walls and semi-flush mounted to walls constructed of gypsum wall board. Where more than two appliances are located in the same room or corridor or field of view, provide synchronized operation. Devices shall use screw terminals for all field wiring.

2.11 SMOKE DETECTOR REMOTE STATUS AND ALARM INDICATORS

- A. Remote power/alarm indicator and key switch. Contains green and red LED power/alarm indicators and keyed test/reset switch mounted on a stainless steel plate.

2.12 MAGNETIC DOOR HOLDERS

- A. Description: Units are equipped for wall mounting and are complete with matching doorplate.
 - 1. Electromagnet: Requires no more than 3 W to develop 25-lbf (111-N) holding force.
 - 2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
 - 3. Rating: 120-V ac.
 - 4. May be controlled directly from the FACP or remotely via a local unswitched 120 volt circuit controlled by an addressable interface device.
- B. Material and Finish: Match door hardware.

2.13 REMOTE ANNUNCIATOR PANEL

- A. Description: Annunciator functions shall match those of fire-alarm control panel for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control panel, including acknowledging, silencing, resetting, and testing.
 - 1. Mounting: Surface cabinet, NEMA 250, Type 1.

2. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control panel. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.14 FIRE ALARM GRAPHIC DISPLAY

- A. Graphic Display Panel: Provides easy identification of building layout and location of fire events on custom floor plan display.
 1. Full color image printed on the reverse side of a .12 mil thick polycarbonate film, fire rated Class A, ASTM E84, matte finish.
 2. Standard white background with colored image line work.
 3. Rigid 1/4" ABS back plate
 4. Architecturally designed low profile aluminum frame with natural aluminum matte finish
 5. Continuous 1/2" inlay accent trim (reflective red, reflective blue, reflective black, beige or custom color).
 6. Concealed hardware, eliminating tampering.
 7. Custom Size: 30" x 42"
 8. The room mapping shown on the graphic display panel shall be verified with the actual field conditions prior to submitting the mapping layout for Owner approval. Prior to the submittal, the contractor shall walk the building along with the Construction Manager and Owner to confirm the room numbers and layout.

2.15 DIGITAL ALARM COMMUNICATOR TRANSMITTER

- A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632 and be listed and labeled by an NRTL.
- B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control panel and automatically capture two telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.
- C. Local functions and display at the digital alarm communicator transmitter shall include the following:
 1. Verification that both telephone lines are available.
 2. Programming device.
 3. LED display.

4. Manual test report function and manual transmission clear indication.
5. Communications failure with the central station or fire-alarm control panel.

D. Digital data transmission shall include the following:

1. Fire alarm-initiating device.
2. Trouble signal.
3. Supervisory signal.
4. Loss of ac supply or loss of power.
5. Low battery.
6. Abnormal test signal.
7. Communication failure.
8. Phone line trouble.

E. Secondary Power: Integral rechargeable battery and automatic charger.

F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.16 DEVICE GUARDS

A. Physical Damage Guards: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.

1. Factory fabricated and furnished by manufacturer of device.
2. Finish: Paint of color to match the protected device.

B. Pull Station Protective Guard

1. The cover shall be provided for all manual pull stations.
2. Guard shall consist of a clear, tamperproof, tough polycarbonate shield, frame, and piezo horn,
3. When the protective guard with horn is lifted to gain access to the protected alarm, a piercing self-contained 95 or 105 dB warning horn (at one foot) shall sound.
4. The cover shall be connected to the frame by a cable. When the cover is lifted, the cover drops off of the frame and the horn shall sound until the cover is snapped back onto the frame.

2.17 ADDITIONAL FIRE ALARM DEVICES

A. Additional fire alarm devices not indicated on drawings, the devices below can be added at any time during construction up to and including project final inspections, base bid price to include device, wiring and programming.

1. Include in bid price, material and labor to wire (3) 3 phase air handling units addressable relays interfaced to existing motor starters for fire alarm fan shut down. Assume wiring lengths of 50' from motor to nearest Signal Line Circuit. Wiring is to be on a per device basis.

2. Include in bid price, material and labor to install (6) new duct smoke detectors in existing air handling equipment and wire said detectors, assuming wiring lengths of 50' from device to nearest Signal Line Circuit. Wiring is to be on a per device basis.
3. Include in bid price material and labor to install (6) new smoke detectors in existing spaces and wire said detectors, assuming wiring lengths of 50' from detector to nearest Signal Line Circuit.
4. Include in bid price material and labor to install (4) new fire alarm pull stations in existing spaces and wire said pull stations, assuming wiring lengths of 50' from device to nearest Signal Line Circuit. Wiring is to be on a per device basis.
5. Include in bid price material and labor to install (4) new fire alarm strobe lights in existing spaces and wire said strobe lights, assuming wiring lengths of 50' from strobe to nearest Notification Appliance Circuit. Wiring is to be on a per device basis.
6. Include in bid price material and labor to install (4) new fire alarm speaker\strobes in existing spaces and wire said horn\strobe, assuming wiring lengths of 50' from device to nearest Signal Line Circuit, Wiring is to be on a per device basis.

2.18 FIRE ALARM WIRE AND CABLE

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Comtran Corporation.
 2. Draka Cableteq USA.
 3. Genesis Cable Products; Honeywell International, Inc.
 4. Rockbestos-Suprenant Cable Corp.
 5. West Penn Wire; a brand of Belden Inc.
- B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.
- C. Signaling Line Circuits: Twisted, shielded pair, or twisted, unshielded pair, not less than No. 16 AWG. Refer to fire alarm system manufacturer for recommended sizes and shielding requirements.
- D. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.
 1. Low-Voltage Circuits: No. 16 AWG, minimum.
 2. Line-Voltage Circuits: No. 12 AWG, minimum.

PART 3 - EXECUTION

3.1 VERIFICATION OF CONDITIONS (BY INSTALLER)

- A. Verification of Conditions (by Installer): Examine conditions under which fire alarm system is to be installed in coordination with Installer of materials and components specified in this Section and notify affected Contractors and Architect in writing of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to Installer.
 - 1. When Installer confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to Architect written confirmation from applicable Installer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to Installer.

3.2 PROTECTION

- A. Protection: Provide dust covers on all detectors during construction.

3.3 EQUIPMENT INSTALLATION

- A. Install fire alarm system in accordance with applicable provisions of NEC, NFPA-70, Article 760 - Fire Protective Signaling Systems.
 - 1. Contractor performing fire alarm system work shall be a licensed fire alarm contractor. Contractor shall provide Fire Alarm Installation Certification with fire alarm system submittal.
 - 2. Since existing fire alarm systems are being replaced, Contractor performing fire alarm system work shall comply with the requirements of the local Fire Marshall concerning the fire alarm system shutdown plans, procedures, and fire watch plans that will be implemented for system interruptions during construction. All existing fire alarm devices shall remain active until new cabling and devices are installed. Temporary interruptions are allowed while work is being done on the system. Work shall be coordinated so that system is fully functional at the end of the workday. If system is not fully functional at end of workday, Contractor shall provide personnel for fire watch as required by local Fire Marshall and shall be responsible for all associated costs.
 - 3. Provide all labor, materials, equipment and services to perform all operations required for complete installation of fire alarm system and related construction as shown on Drawings and specified in this Section.
 - 4. Completely check, program and adjust all new and existing equipment on each system.
 - 5. Label each addressable device with label indicating device's unique address. Label shall comply with Specification Section 26 05 53 Identification for Electrical Systems. Labels shall be installed so that they are visible without removing device from mounting base.

B. Manual Fire-Alarm Boxes:

1. Install manual fire-alarm box in the normal path of egress within 60 inches (1520 mm) of the exit doorway.
2. Mount manual fire-alarm box on a background of a contrasting color.
3. The operable part of manual fire-alarm box shall be between 42 inches (1060 mm) and 48 inches (1220 mm) above floor level. All devices shall be mounted at the same height unless otherwise indicated.

C. Smoke- or Heat-Detector Spacing:

1. Comply with NFPA 72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke-detector spacing.
2. Comply with NFPA 72, "Heat-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for heat-detector spacing.
3. For smoke detectors, smooth ceiling spacing shall not exceed 30 feet (9 m).
4. For heat detectors, smooth ceiling spacing shall not exceed 30 feet (9 m).
5. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A in NFPA 72.
6. HVAC: Locate detectors not closer than 3 feet (1 m) from air-supply diffusers or return-air openings.
7. Lighting Fixtures: Locate detectors not closer than 12 inches (300 mm) from any part of a lighting fixture.

D. Install 200 deg. F. fixed temperature heat detectors in Kitchens and Boiler Rooms. Install 135 deg. F. fixed temperature heat detectors in areas where sudden temperature changes can be anticipated (near overhead doors, heating units, etc.).

E. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install supply duct detectors downstream of the air filters and ahead of any branch connections. Install return duct detectors between the air handling unit and any recirculation or fresh air inlet connection. Install sampling tubes so they extend the full width of duct.

F. Fan shutdown relays shall be wired to stop unit with motor controller's control switch in any position. Locate shut down relay within 3 feet of motor controller.

G. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.

H. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.

I. In areas where detection and notification devices may be subject to physical damage, devices shall have protective wire guards as manufactured by Safety Technology International (www.sti-usa.com). All guards shall be listed for the fire alarm system devices and appliances protected.

J. Install all devices on exterior of building in weatherproof enclosures supplied by device manufacturer.

- K. In new construction, install all devices flush or semi-flush mounted, unless otherwise authorized by Owner.
- L. In existing construction, install all interior surface mounted devices on surface mounted back boxes supplied by device manufacturer.
- M. In locations where new devices are replacing existing, contractor shall coordinate removal/replacement to allow re-use of existing backbox/conduits if possible.
- N. In locations where building construction prohibits flush-mounted installations, provide surface raceway. At such locations obtain written authorization from Owner's representative or Architect prior to providing surface raceway device.
- O. Demolition of existing system:
 - 1. Disconnect and remove existing fire alarm system in its entirety, inclusive of all wiring, devices, raceway, and controls.
 - 2. Repair all damaged surfaces upon removal of existing devices and raceway. Repair and patch existing construction to match existing finishes.
- P. Heat Detectors in Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location.
- Q. Remote Status and Alarm Indicators: Install near each duct detector, smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.
- R. Wire the Notification Appliance Circuits such that the audible alarm indicating devices can be turned off while the visual alarm notifications remain operational.
- S. Locate audible/visible signaling devices in strict accordance with requirements of Americans with Disabilities Act (ADA).
- T. Audible Alarm-Indicating Devices: Install not less than 6 inches (150 mm) below the ceiling. Install speakers on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.
- U. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and place strobe light lens 80 inches minimum and 96 inches maximum above floor level. In locations where ceiling height is less than 90 inches AFF, place strobe light lens 6 inches below ceiling.
- V. Where combination audible/visible units used, place strobe light lens 80 inches minimum and 96 inches maximum above floor level. In locations where ceiling height is less than 90 inches AFF, place strobe light lens 6 inches below ceiling.
- W. Device Location-Indicating Lights: Locate in public space near the device they monitor.
- X. Fire-Alarm Control Panel: Surface mounted, with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.

- Y. Fire Alarm Graphic Display: Install with top of display not more than 72 inches (1830 mm) above the finished floor.

3.4 WIRING

- A. Install Type FPLP plenum rated fire alarm cable for all initiating circuit wiring and notification circuit wiring, sized in accordance with manufacturer's recommendations.
- B. Signaling Line Circuits: Power-limited fire alarm cables shall not be installed in the same cable or raceway as signaling line circuits.
- C. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
- D. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.
- E. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.
- F. Install all plenum cable above corridor ceilings bundled and tie-wrapped at 5 foot intervals and hung in saddle rings or J-hooks, supported to structure at 5 foot intervals.
- G. Cable shall not be considered properly supported by lying over top of conduits, piping, or building supports or bracing. Approved saddle rings or J-hooks must be used.
- H. For wall mounted devices in existing construction where wiring cannot be concealed, all wiring shall be installed in surface metallic raceway from device location to an accessible ceiling space.
- I. Install all wiring in approved surface metallic raceway or EMT conduit in the following locations:
 - 1. Unfinished areas (EMT conduit).
 - 2. Exposed areas (Surface metallic raceway).
 - 3. Where subject to damage.

3.5 CONNECTIONS

- A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Division 08 Section "Door Hardware." Connect hardware and devices to fire-alarm system.
 - 1. Verify that hardware and devices are NRTL listed for use with fire-alarm system in this Section before making connections.
- B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
 - 1. Smoke dampers in air ducts of designated air-conditioning duct systems.
 - 2. Alarm-initiating connection to elevator recall system and components.
 - 3. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
 - 4. Supervisory connections at valve supervisory switches.
 - 5. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
 - 6. Supervisory connections at elevator shunt trip breaker.
 - 7. Supervisory connections at fire-pump power failure including a dead-phase or phase-reversal condition.
 - 8. Supervisory connections at fire-pump engine control panel.

3.6 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- B. Install framed instructions in a location visible from fire-alarm control panel.

3.7 GROUNDING

- A. Ground fire-alarm control panel and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control panel.

3.8 ADJUSTING / CLEANING

- A. Completely clean all smoke detectors, as instructed by authorized factory representative, when system is substantially complete and when authorized by Owner.

3.9 FIELD QUALITY CONTROL

- A. Field tests shall be witnessed by Owner's Representative and authorities having jurisdiction.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Visual Inspection: Conduct visual inspection prior to testing.
 - a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.
 - b. Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
2. Perform 100 percent inspection and testing of all system devices.
 - a. Provide complete panel real-time printout as documentation of device, date and time. Any acceptance test not accompanied by real-time printout requires retesting of entire system by Contractor, including both alarm activation tests and tests of supervisory circuit at each device.
 - b. Provide inspection complying with requirements of applicable NFPA standards.
 - c. Provide to Owner and Fire Code Official complete typed list of every initiation, signaling, control, supervisory and auxiliary device with specific information regarding system address of device, location of device, date tested, manufacturer's model number, and serial number of all analog components, status of device and zone or point as related to system. Obtain from Owner, the Owner's room names/numbers that are to be assigned to each device.
3. Provide complete set of battery test results for panels including:
 - a. Charger output voltage under normal conditions.
 - b. Charger output current under normal conditions.
 - c. Open battery voltage.
 - d. Supply voltage and current under primary power failure.
 - e. Supply voltage and current under primary power failure and system alarm that has activated all of panel's audible, visual and control circuits.
 - f. Calculations using battery test data obtained to determine minimum battery capacity of 24 hours under normal conditions and 5-minute alarm condition.
4. Take voltage readings at end of line of each alarm signal circuit to insure minimum operational levels.
 - a. If voltage drop exceeds the minimum rating of the last device in the circuit, while under full circuit load, rewire circuits with appropriately heavier gage wire as required to comply with specified requirements.
5. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.

6. Test visible appliances for the public operating mode according to manufacturer's written instructions.
7. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.

D. Intelligibility Tests

1. Intelligibility testing of the System shall be accomplished in accordance with NFPA 72 for Voice Evacuation Systems, IEC 60268-16, and ASA S3.2. Following are the specific requirements for intelligibility tests:
 - a. Intelligibility Requirements: Verify intelligibility by measurement after installation.
2. Ensure that a CIS value greater than the required minimum value is provided in each area where building occupants typically could be found. The minimum required value for CIS is .7
3. The contractor must submit a waiver letter for areas of the building they believe will not meet the minimum CIS value at the beginning of the shop drawing phase. Areas of the building provided with hard wall and ceiling surfaces (such as metal or concrete) that are found to cause excessive sound reflections may be permitted to have a CIS score less than the minimum required value if building occupants in these areas can determine that a voice signal is being broadcast and they must walk no more than 33 feet to find a location with at least the minimum required CIS value within the same area.
4. Areas of the building where occupants are not expected to be normally present are permitted to have a CIS score less than the minimum required value if personnel can determine that a voice signal is being broadcast and they must walk no more than 50 feet to a location with at least the minimum required CIS value within the same area.
5. Take measurements near the head level applicable for most personnel in the space under normal conditions (e.g., standing, sitting, sleeping, as appropriate).
6. The distance the occupant must walk to the location meeting the minimum required CIS value shall be measured on the floor or other walking surface as follows:
 - a. Along the centerline of the natural path of travel, starting from any point subject to occupancy with less than the minimum required CIS value.
 - b. Curving around any corners or obstructions, with a 12 inch clearance there from.
 - c. Terminating directly below the location where the minimum required CIS value has been obtained.
7. Use commercially available test instrumentation to measure intelligibility as specified by ISO 7240-19 and ISO 7240-16 as applicable. Use the mean value of at least three readings to compute the intelligibility score at each test location.

- E. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
- F. Fire-alarm system will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.
- H. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.10 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 - 1. Include visual inspections according to the "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - 2. Perform tests in the "Test Methods" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - 3. Perform tests per the "Testing Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.11 SOFTWARE SERVICE AGREEMENT

- A. Comply with UL 864.
- B. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for one year.
- C. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within one year from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
 - 1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

3.12 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system. Training shall consist of a total of 8 hours delivered in 2 hour blocks.
- B. Provide copy of sign-in sheet of District staff receiving training in O&M Manuals.

END OF SECTION 28 31 11

SECTION 31 10 00 - SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Protecting existing vegetation to remain.
 - 2. Removing existing vegetation.
 - 3. Clearing and grubbing.
 - 4. Stripping and stockpiling topsoil.
 - 5. Removing above and below-grade site improvements.
 - 6. Disconnecting, capping or sealing, and removing site utilities.
 - 7. Temporary erosion and sedimentation-control measures.
 - 8. Disposal of waste material.

1.3 DEFINITIONS

- A. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
- B. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.
- C. Topsoil (insitu): Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.
- D. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, defined by a circle concentric with each tree with a radius 1.5 times the diameter of the drip line unless otherwise indicated on Drawings.
- E. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 MATERIAL OWNERSHIP

- A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 SUBMITTALS, GENERAL

- A. General: Submit all informational submittals required by this Section concurrently.

1.6 INFORMATIONAL SUBMITTALS

- A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.
 - 1. Use sufficiently detailed photographs or video.
 - 2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.

1.7 CLOSEOUT SUBMITTALS

- A. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.8 PROJECT CONDITIONS

- A. Verification of Conditions: Examine conditions under which site clearing is to be accomplished and notify Architect in writing of any conditions detrimental to proper and timely accomplishment. Do not proceed with site clearing until unsatisfactory conditions have been corrected.
- B. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 - 2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.
- C. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises in location to be determined by Owner.
- D. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.
- E. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.

- F. The following practices are prohibited within protection zones:
1. Storage of construction materials, debris, or excavated material.
 2. Parking vehicles or equipment.
 3. Foot traffic.
 4. Erection of sheds or structures.
 5. Impoundment of water.
 6. Excavation or other digging unless otherwise indicated.
 7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
- G. Do not direct vehicle or equipment exhaust towards protection zones.
- H. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.
- I. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 31 20 00 "Earth Moving."
1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Locate and clearly identify trees, shrubs, and other vegetation to remain. Flag each tree trunk at 54 inches above the ground.
- C. Protect existing site improvements to remain free from damage during construction.
1. Restore damaged improvements to their original condition, as acceptable to Owner.
- D. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction. Refer to Section 31 25 00, "Erosion and Sedimentation Controls".
- B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross tree or plant protection zones.
- C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
- D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

- A. General: Protect trees and plants remaining on-site according to requirements in Section 31 25 00 "Erosion and Sedimentation Controls."
- B. Should any trees or shrubs be damaged which are to be saved, arrange to have such damage treated by a licensed arborist or tree surgeon.
- C. Protect tree and shrub root systems from smothering. Do not store construction materials, debris, or excavated material within plant protection zone. Do not permit vehicular traffic or parking within plant protection zone. Restrict foot traffic to prevent excessive compaction of soil over tree, shrub and turf root systems.
- D. Trees or shrubs which die because of the Contractor's failure to conform to the Drawings and specifications shall be evaluated by a qualified organization selected by the Owner's Representative. The removal and replacement of the tree, and the evaluation expenses shall be paid for by the Contractor. Contractor shall be required to replace the damaged tree with plant material of comparable size and quality (i.e. damaged 12" caliper Red Maple shall be replaced by three 4" cal. or four 3" cal. Red Maples). Substitutions for variety shall be approved by the Architect.

3.4 EXISTING UTILITIES

- A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed.
 - 1. Arrange with utility companies to shut off indicated utilities.
- B. Locate, identify, and disconnect utilities indicated to be abandoned in place.
- C. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect not less than ten (10) working days in advance of proposed utility interruptions.
- D. Excavate for and remove underground utilities indicated to be removed.

3.5 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
 2. Grind down stumps and remove roots, obstructions, and debris to a minimum depth of 18 inches below exposed subgrade.
 3. Use only hand methods for grubbing within protection zones.
 4. Chip removed tree branches and dispose of off-site.
- B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer in accordance with Section 31 20 00 "Earth Moving".

3.6 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil in a manner to prevent intermingling with underlying subsoil or other waste materials.
- C. Do not remove surplus topsoil from site.
- D. Refer to Section 32 92 00 "Turfs and Grasses" for topsoil screening requirements.
- E. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects more than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.
- F. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.
1. Limit height of topsoil stockpiles to 72 inches.
 2. Do not stockpile topsoil within protection zones.

3.7 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction including foundations, slabs, paving, curbs, gutters, retaining walls, aggregate base and other improvements.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically. Leave cut edge neat and square where existing material is cut to adjoin new work.
2. Remove asphalt concrete paving material to full depth and remove from site. Do not use asphalt materials for on-site fill.
3. Gravel and stone fill under removed sidewalks may be reused if suitable for the particular new use and if approved by the Architect.
4. Break up and completely remove miscellaneous concrete, such as small foundations. Remove concrete, retaining walls or foundations below grade to a minimum depth of 2'.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

END OF SECTION 31 10 00

SECTION 31 20 00 - EARTH MOVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Preparing subgrades for foundations, slabs-on-grade, walks, pavements, turf and grasses.
2. Structural Fill: For backfill under structures, pavements, concrete pads, etc.
3. Granular Fill: Sub base for interior concrete slabs-on-grade, asphalt paving, concrete paving, etc.
4. Subsurface drainage fill for foundation drains, underdrains, etc.
5. Excavating and backfilling for buildings and structures.
6. Excavating and backfilling trenches for utilities and pits for buried utility structures.

B. Related Requirements:

1. Section 31 10 00 - Site Clearing

1.3 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Subbase: Granular aggregate layer supporting the slab-on-grade and pavement that also minimizes upward capillary flow of pore water.

G. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Geotechnical Engineer. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices, if specified, or changes in the Work.
 2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.
 3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Geotechnical Engineer or Architect. Unauthorized excavation, as well as remedial work directed by Geotechnical Engineer or Architect shall be without additional compensation.
- H. Fill: Soil materials used to raise existing grades.
- I. Hazardous Soil Materials: Soils that are contaminated with petroleum product and/or hazardous chemicals, waste or industrial waste.
- J. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cu. yd. for bulk excavation or for footing, trench, and pit excavation that cannot be removed by rock excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:
1. Rock Excavation: Track-mounted excavator rated at not less than 222-hp flywheel power with weight of 70,000 lbs or greater and a 30-in wide short-tip radius rock bucket. (Ratings are based on Caterpillar's "Model No. 330B".)
- K. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- L. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below aggregate base, structural fill, drainage fill, or topsoil materials.
- M. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.
- N. Non-Granular Fill: Soil fill material used to raise existing grades in areas that do not require granular or structural fill.
- O. Well-Graded: Soils containing a good range of all representative particle sizes between the largest and the smallest. All sizes must be represented, and no one size should be either overabundant or missing.
- P. Poorly-Graded: Soils which either contain a narrow range of particle sizes or have some intermediate sizes lacking.

1.4 SUBMITTALS

- A. General: Submit all action submittals and informational submittals required by this Section concurrently.
- B. Action Submittals:
 - 1. Product Data: For each type of the following manufactured products required:
 - a. Geotextiles.
 - b. Warning tapes.
 - 2. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:
 - a. Classification according to ASTM D 2487.
 - b. Laboratory compaction curve according to ASTM D 1557.
 - c. Submitted material testing and analysis shall demonstrate that no unsuitable soil groups are present.
 - d. Submitted material testing and analysis shall demonstrate that no absorbent clays are present.
 - 3. Delegated-Design Submittal:
 - a. For excavations greater than or equal to 20 feet in depth require engineered systems design per OSHA requirements, signed and sealed by a professional engineer, and submitted for review.
 - b. Plan for protection of persons passing excavations including diagram or description of means and methods to protect all people [from project hazards through the duration of the project shall be submitted for review.
 - 4. Samples for Verification: For the following products, in sizes or quantities indicated below:
 - a. Fill: One-half gallon by volume of material in sturdy container of each type of fill, naming source for each material.
 - b. Geotextile: 12 by 12 inches.
 - c. Warning Tape: 12 inches long; of each color.
 - 5. Verification of Conditions: Written confirmation from installer that installation of Earthwork Materials installed in accordance with specifications.
- C. Informational Submittals:
 - 1. Qualification Data: For qualified testing agency.
 - 2. Pre-excavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces, which might be misconstrued as damage caused by earth moving operations. Submit before earth moving begins.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Qualified Installers as defined below:
1. Earthwork Contractor Experience Requirements: Provide a list of at least four Earthwork projects of comparable size, scope, and quality completed successfully by the proposed Sub Contractor within the past two years that includes the date completed, project Owner's name and current contact information, including telephone numbers and e-mail addresses.
- B. Civil/Structural Preconstruction Conference: Attend Civil/Structural Preconstruction Conference.

1.6 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth moving operations.
1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.
- B. Improvements on Adjoining Property: If work includes improvements on adjoining property, written authorization for performing earth moving indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.
1. Do not proceed with work on adjoining property until directed by Architect.
- C. Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth moving operations.
- D. Do not commence earth moving operations until temporary and permanent erosion- and sedimentation-control measures, specified in Division 31 Section "Erosion and Sedimentation Control" are in place.
- E. Do not commence earth moving operations until plant-protection measures specified in Division 31 Sections "Erosion and Sedimentation Control" and "Site Clearing" are in place.
- F. The following practices are prohibited within tree- or plant-protection zones:
1. Storage of construction materials, debris, or excavated material.
 2. Parking vehicles or equipment.
 3. Foot traffic.
 4. Erection of sheds or structures.
 5. Impoundment of water.
 6. Excavation or other digging unless otherwise indicated.
 7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

8. Directing vehicle or equipment exhaust towards protection zones.
9. Heat sources, flames, ignition sources, and smoking within or near protection zones.

G. Existing Hazardous Materials:

1. If during the performance of the work suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. If present, hazardous materials will be removed by Owner under a separate contract.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Soil Materials:

1. General: Provide imported soil materials when sufficient satisfactory soil materials are not available from onsite excavations.
2. Topsoil: Refer to Turf and Grasses Specification, Division 32.

B. Hazardous Materials:

1. Provide fill materials that are not contaminated with petroleum product, hazardous waste or industrial waste.
2. Contamination above federal, state or local requirements is not acceptable. Materials with a visible sheen or petroleum odor shall be rejected.

C. Unsuitable Soils: (Includes excavated native and imported non-granular, granular and structural fill materials)

1. Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.
 - a. Soils Materials shall not contain any absorbent aluminum phyllosilicates, including but not limited to: bentonite (sodium, calcium, or potassium), tonstein, montmorillonite, kaolinite. or other absorbent clays.
2. Unsuitable soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
3. Submitted material testing and analysis shall demonstrate that material classification meets ASTM-D2487 USC system criteria and that no unsuitable soil groups, or absorbent clays are present.

D. Non-Granular Fill: Material is to comply with NYSDOT requirements for Select Borrow and Select Fill with modifications shown below. This material is not allowed in areas where granular soils are required, including within the building footprint, below pavement areas or below a synthetic turf athletic field.

1. On-Site Non-Granular Fill

- a. Submittal must be provided demonstrating that on-site soil material meets the criteria outlined in this Section for use as fill material.
- b. Obtain approval of Architect before proceeding with use of on-site material.
- c. Material is to have no particles greater than 3" in maximum dimension, no more than 70% by weight passing the #40 sieve and no more than 20% passing the #200 sieve.
- d. Testing submitted is to demonstrate that proper compaction can be achieved as required in Part 3, Execution.

2. Imported Non-Granular Fill

- a. Where quantity of approved non-granular fill materials required exceeds that available from on-site stock-piles, provide suitable material from off-site sources.
- b. Obtain approval of Architect before proceeding with use of imported fill material.
- c. Material is to have no particles greater than 3" in maximum dimension, no more than 70% passing by weight the #40 sieve and no more than 15% passing the #200 sieve.
- d. Testing submitted is to demonstrate that proper compaction can be achieved as required in Part 3, Execution.

E. Structural Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand, complying with New York State Department of Transportation (NYSDOT) Standard Specification, Section 304, as modified below:

1. Type 2 Fill (NYSDOT ITEM No. 304.12 / Crushed / Blasted Ledge Rock Stone) Gradation Requirements.

Sieve Designation	Percent by Weight Passing Square Mesh Sieves
2 inch	100
1/4-inch	25 to 60
#40	5 to 40
#200	0 to 10
#200	0 to 10

F. Granular Fill: Import all granular fill types from off-site sources. Granular fill consists of stone, sand, and gravel, or blends of these materials, free of slag, complying with New York State Department of Transportation (NYSDOT) Standard Specification Item 203.07.

- G. Crushed Stone: Crushed stone to comply with New York State Department of Transportation (NYSDOT) Standard Specifications, Section 703-0201 which is product of mechanical crushing. Where indicated, provide the following fill materials, consisting of clean, free of slag, durable, sharp-angled fragments of rock of uniform quality. The crushed stone used as coarse aggregate for all items shall be obtained from sources conforming to the requirements of the NYSDOT as to sampling, testing methods, Quarry Reports and any other required procedures and complying with following requirements:

1. NYSDOT No. 1 Crushed Stone Gradation Requirements (NYSDOT 703-4 # 1 Stone):

Sieve Designation	Percent by Weight Passing Square Mesh Sieves
1 inch	100
1/2-inch	90 to 100
1/4-inch	0 to 15
#200	0 to 1

2. NYSDOT No. 2 Crushed Stone Gradation Requirements (NYSDOT 703-4 #2 Stone):

Sieve Designation	Percent by Weight Passing Square Mesh Sieves
1-1/2 inch	100
1 inch	90 to 100
1/2-inch	0 to 15
#200	0 to 1

- H. Drainage Fill: Mixture of 50 percent NYSDOT No. 1 crushed stone and 50 percent NYSDOT No. 2 crushed stone, complying with New York State Department of Transportation Standard Specifications Table 733-20A Underdrain Filter Material Gradation.

Sieve Designation	Percent by Weight Passing Square Mesh Sieves
1- inch	100
1/2 inch	30 to 100
1/4-inch	0 to 30
# 10	0 to 10
# 20	0 to 5

2.2 GEOTEXTILES

- A. Separation/Filter Fabric - Nonwoven needle-punched polypropylene geotextile filter/separation fabric complying with the following:

Fabric Property	Value	Test Method
Grab Tensile Strength	205 lb	ASTM D 4632
Grab Tensile Elongation	50 percent	ASTM D 4632
Trapezoid Tear Strength	80 lbs	ASTM D 4533
CBR Puncture Strength	500 lbs min	ASTM D 6241

Apparent Opening Size	No. 80 sieve max	ASTM D 4751
Permittivity	1.4 sec ⁻¹	ASTM D 4491
Flow Rate	95 gal min/ft ²	ASTM D 4491
UV Stability	70% after 500 hours	ASTM D 4355

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. TenCate Mirafi - 180N
- b. Amoco - 4553
- c. Geotex – 801

B. Soil Stabilization Geogrid:

1. Geogrid manufactured from a punched polypropylene sheet, which is then oriented in three substantially equilateral directions so that the resulting ribs shall have a high degree of molecular orientation, which continues at least in part through the mass of the integral node.
2. Heavy duty, commercially manufactured Geogrid meeting the following properties:

Fabric Property	Test Method	Unit	Typical Value
Rib Pitch - Longitudinal	ASTM D 4759-02	Inch (nom.)	1.60
Rib Pitch - Diagonal	ASTM D 4759-02	Inch (nom.)	1.60
Mid Rib Depth - Diagonal	ASTM D 4759-02	Inch (nom.)	0.05
Mid Rib Depth - Transverse	ASTM D 4759-02	Inch (nom.)	0.05
Mid Rib Width - Diagonal	ASTM D 4759-02	Inch (nom.)	0.04
Mid Rib Width - Transverse	ASTM D 4759-02	Inch (nom.)	0.04
Rib Shape	N/A	N/A	Rectangular
Aperture Shape	N/A	N/A	Triangular
Junction Efficiency	ASTM D 6637-10 ASTM D7737-11	%	93
Radial Stiffness @ Low Strain	ASTM D 6637-10	lb / ft @ 0.5% strain	15,430
Chemical Degradation Resistance	EPA 9090	N/A	100%
UV Light & Weathering Resistance	ASTM D 4355-05	N/A	70%

3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. Tensar Corporation - Triax TX140.

C. Subsurface Drainage Geotextiles: Refer to Division 33 Section "Storm Utility Drainage Piping".

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Examine conditions under which earthwork is to be accomplished in coordination with Installer of materials and components specified in this Section and notify affected Prime Contractors and Architect in writing of any conditions detrimental to proper and timely accomplishment. Do not proceed with earthwork until unsatisfactory conditions have been corrected in manner acceptable to Installer.
 - 1. When Installer confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to Architect written confirmation from applicable Installer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to Installer.

3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.
 - 1. Contractor is entirely responsible for strength and adequacy of bracing and shoring, and for safety and support of construction from damage or injury caused by lack of adequate protection or by movement or settlement.
 - 2. Contractors are advised that they are required to comply with Occupational Safety and Health Administration's (OSHA) standards pertaining to excavation.
 - 3. All excavations must be barricaded at all times using either traffic or A-Frame type barricades. Gaps between barricades may be up to 6-inches wide and must be blocked with caution tape.
- B. Protect and maintain erosion and sedimentation controls during earth moving operations.
- C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.3 UNDERGROUND UTILITY SURVEY

- A. An underground utility survey must be conducted prior to the start of any excavation. Call 811

3.4 DEWATERING

- A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

- B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

- 1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.5 EXPLOSIVES

- A. Explosives: Do not use explosives.

3.6 SITE CLEARING

- A. Refer to Division 31 Section "Site Clearing".

3.7 EXCAVATION, GENERAL

- A. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by Geotechnical Engineer. The Contract Sum will be adjusted for rock excavation according to unit prices included in the Contract Documents. Changes in the Contract Time may be authorized for rock excavation.

- 1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation.

- a. Intermittent drilling; ram hammering; or ripping of material not classified as rock excavation is earth excavation.

- 2. Rock excavation includes removal and disposal of rock (refer to Definitions section: "Rock" paragraph above). Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction without exceeding the following dimensions:

- a. 24 inches outside of concrete forms other than at footings.
 - b. 12 inches outside of concrete forms at footings.
 - c. 6 inches outside of minimum required dimensions of concrete cast against grade.
 - d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
 - e. 6 inches beneath bottom of concrete slabs-on-grade.
 - f. 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.

3.8 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

- a. See Structural Drawings for specific removal and replacement instructions if required.

B. Excavations at Edges of Tree- and Plant-Protection Zones:

1. Excavate by hand to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Protect trees and other plants in accordance with requirements in Division 1 Section "Temporary Facilities and Controls" and Division 31 Section "Erosion and Sedimentation Control".

3.9 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.10 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

- B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.

1. Clearance: 12 inches each side of pipe or conduit.

- C. Trench Bottoms: Excavate trenches 6 inches (150 mm) deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe. Remove projecting stones and sharp objects along trench subgrade.

- D. Trenches in Tree- and Plant-Protection Zones:

1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.
3. Cut and protect roots in accordance with standard nursery practice and Division 31 Section "Erosion and Sedimentation Control".

3.11 SUBGRADE INSPECTION

- A. Notify Architect when excavations have reached required subgrade.
- B. If Geotechnical Engineer determines that unsuitable soil is present, continue excavation and replace with compacted backfill or fill material as directed.

3.12 PROOF-ROLLING

- A. Proof-roll subgrade below building slabs, concrete pads and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing 15 tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
 - 1. Completely proof-roll subgrade in one direction and repeating proof-rolling in direction perpendicular to first direction with a minimum of six overlapping passes. Limit vehicle speed to 3 mph.
 - 2. Excavate soft spots, unsuitable soils, and areas of excessive pumping or rutting, as identified by Geotechnical Engineer and as directed by Owner, and replace with compacted backfill or fill as directed. Notify Architect in writing of any required remediation.
 - 3. Foundations: Proof-roll prior to excavation for foundations but after top soil is stripped.
- B. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices (if applicable) or changes in the Work.
- C. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities without additional compensation.

3.13 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. CLSM (flowable fill), per this specification section, may be used when approved by Architect.
 - 1. Fill unauthorized excavations under other construction, pipe, or conduit in accordance with this Section unless otherwise directed by Geotechnical Engineer.

3.14 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 - 1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.15 SOIL STABILIZATION FABRIC

- A. Install soil stabilization fabric: After subgrade has been compacted and proof-rolled, install soil stabilization fabric as specified by the manufacturer, including the following:
 - 1. Lay fabric in the direction of traffic.
 - 2. Overlap fabric side to side and end to end a minimum of two feet.
 - 3. Insure that fabric lies flat during fill placement.

3.16 BACKFILL

- A. Place and compact backfill in excavations promptly, but not before completing the following:
 - 1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
 - 2. Surveying locations of underground utilities for Record Documents.
 - 3. Testing and inspecting underground utilities.
 - 4. Removing concrete formwork.
 - 5. Removing trash and debris.
 - 6. Removing temporary shoring and bracing, and sheeting.
 - 7. Installing permanent or temporary horizontal bracing on horizontally supported walls.
- B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.17 UTILITY TRENCH BACKFILL

- A. Place backfill on subgrades free of mud, frost, snow, or ice.
- B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- C. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Division 03 Section "Cast-in-Place Concrete".
- D. Trenches under Roadways: Provide 4-inch- thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase course. Concrete is specified in Division 03 Section "Cast-in-Place Concrete".
- E. Backfill voids with satisfactory soil while removing shoring and bracing.
- F. Place and compact initial backfill of subbase material or satisfactory soil, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.
 - 1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

- G. Controlled Low-Strength Material: Place initial backfill of controlled low-strength material to a height of 12 inches over the pipe or conduit. Coordinate backfilling with utilities testing.
- H. Place and compact final backfill of satisfactory soil to final subgrade elevation.
- I. Controlled Low-Strength Material: Place final backfill of controlled low-strength material to final subgrade elevation.
- J. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.18 SOIL FILL

- A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
- B. Place and compact fill material in layers to required elevations as follows. Refer to Part 2 for material requirements and specific conditions for the use of each type of soil material. All fill materials to be approved by Architect per requirements noted in Part 2.
 - 1. Under grass and planted areas:
 - a. Use satisfactory non-granular fill material.
 - 2. Under walks, pavements and exterior slabs:
 - a. Use Structural Fill below subbase layer and Type 2 granular fill for subbase layer.
 - 3. Under steps and ramps
 - a. Use structural fill below subbase layer and Type 2 granular fill for subbase layer.
 - 4. Under building slabs:
 - a. Use structural fill below subbase layer. For subbase, use No. 2 Crushed Stone. See Drawings for depth.
 - 5. Under footings and foundations:
 - a. Use structural fill.
 - 6. Under catch basins, manholes, vaults or other underground structures.
 - a. Use structural fill or as noted on drawings.
- C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.19 SOIL MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
 - 1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
 - 2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry density.

3.20 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Maximum layer depth before compaction:
 - 1. Under Pavement: Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
 - 2. Place backfill and fill soil materials in layers not more than 12 inches in loose depth for material compacted by heavy compaction equipment, and not more than 8 inches in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.
- C. Compact soil materials to not less than the following percentages of maximum dry weight density according to ASTM D 1557:
 - 1. Under structures, building slabs, steps, synthetic turf and pavements:
 - a. Scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.
 - 2. Under walkways:
 - a. Scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 95 percent.
 - 3. Under natural turf or unpaved areas:
 - a. Compact each layer of subgrade backfill or fill soil material at 85 percent. Compact all layers beneath the upper 2'-0" to at least 95 percent.
 - 4. Utility trenches:
 - a. Compact each layer of initial and final backfill soil material at 85 percent.

5. Landscape Planting Areas:
 - a. Compact each layer of subgrade backfill or fill soil material at 75 percent.
6. Under catch basins, manholes, vaults or other underground structures.
 - a. Scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.

3.21 GRADING

- A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
 1. Provide a smooth transition between adjacent existing grades and new grades.
 2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
- B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
 1. Turf or Unpaved Areas: Plus or minus 1 inch.
 2. Walks: Plus or minus 1 inch.
 3. Pavements: Plus or minus 1/2 inch.
- C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge and within +0" / -1" tolerance of bottom of slab.

3.22 SUBSURFACE DRAINAGE

- A. Drainage Tubing / Subdrainage Pipe: Specified in Division 33 Section "Storm Utility Drainage Piping".
- B. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench as shown in Drawings.
 1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D 698.
- C. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches of final subgrade, in compacted layers 6 inches thick. Overlay drainage backfill with one layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches.
 1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D 698 with a minimum of two passes of a plate-type vibratory compactor.

3.23 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

- A. Place granular fill base course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place granular fill base course under pavements and walks as follows:
 - 1. Place base course material over subgrade under hot-mix asphalt pavement.
 - a. If separation geotextile is shown in details, install on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
 - 2. Shape base course to required crown elevations and cross-slope grades.
 - 3. Place base course 6 inches or less in compacted thickness in a single layer.
 - 4. Place base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
 - 5. Compact base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

3.24 SUB BASE FOR CONCRETE SLABS-ON-GRADE

- A. Place sub base on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place and compact sub base under cast-in-place concrete slabs-on-grade as follows:
 - 1. Place sub base 8 inches or less in compacted thickness in a single layer.
 - 2. Place sub base that exceeds 8 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 8 inches thick or less than 3 inches thick.
 - 3. Compact each layer of sub base to required cross sections and thicknesses to not less than 95 percent of maximum dry density according to ASTM D 4254.

3.25 INSTALLATION OF SURFACE STONE MATERIAL

- A. Place surface stone material (stone dust, cover stone, etc.) on subgrades free of mud, frost, snow, or ice.
- B. Compact so that surface stone layer is consolidated. During installation avoid bringing subgrade material to the surface. If subgrade material becomes intermixed with surface stone, remove contaminated surface stone material and reinstall new surface stone.

3.26 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections unless otherwise noted.

- B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.
- C. Inspections and tests:
 - 1. Geotechnical observations: Proof rolling procedures, site preparation, unsuitable soils removal, excavations, footing bearing, and fill placement.
 - 2. Field Density Testing:
 - a. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Geotechnical Engineer.
 - b. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:
 - 1) Fill under Footings: In each compacted fill layer, 1 compaction test for every 30 linear feet of wall may be taken. 1 compaction test may be made under each individual footing.
 - 2) Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 50 feet or less of wall length, but no fewer than two tests.
 - 3) Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2,000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.
 - 4) Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length, but no fewer than two tests.
 - c. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.
 - 3. Laboratory testing for on-site fills:
 - a. ASTM D 1557 Modified D 698 Standard Proctor compaction curve including sieve analysis.

3.27 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

- B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
 - 1. Scarify or remove and replace soil material to depth as directed by Geotechnical Engineer or Architect; reshape and recompact.
- C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
 - 1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

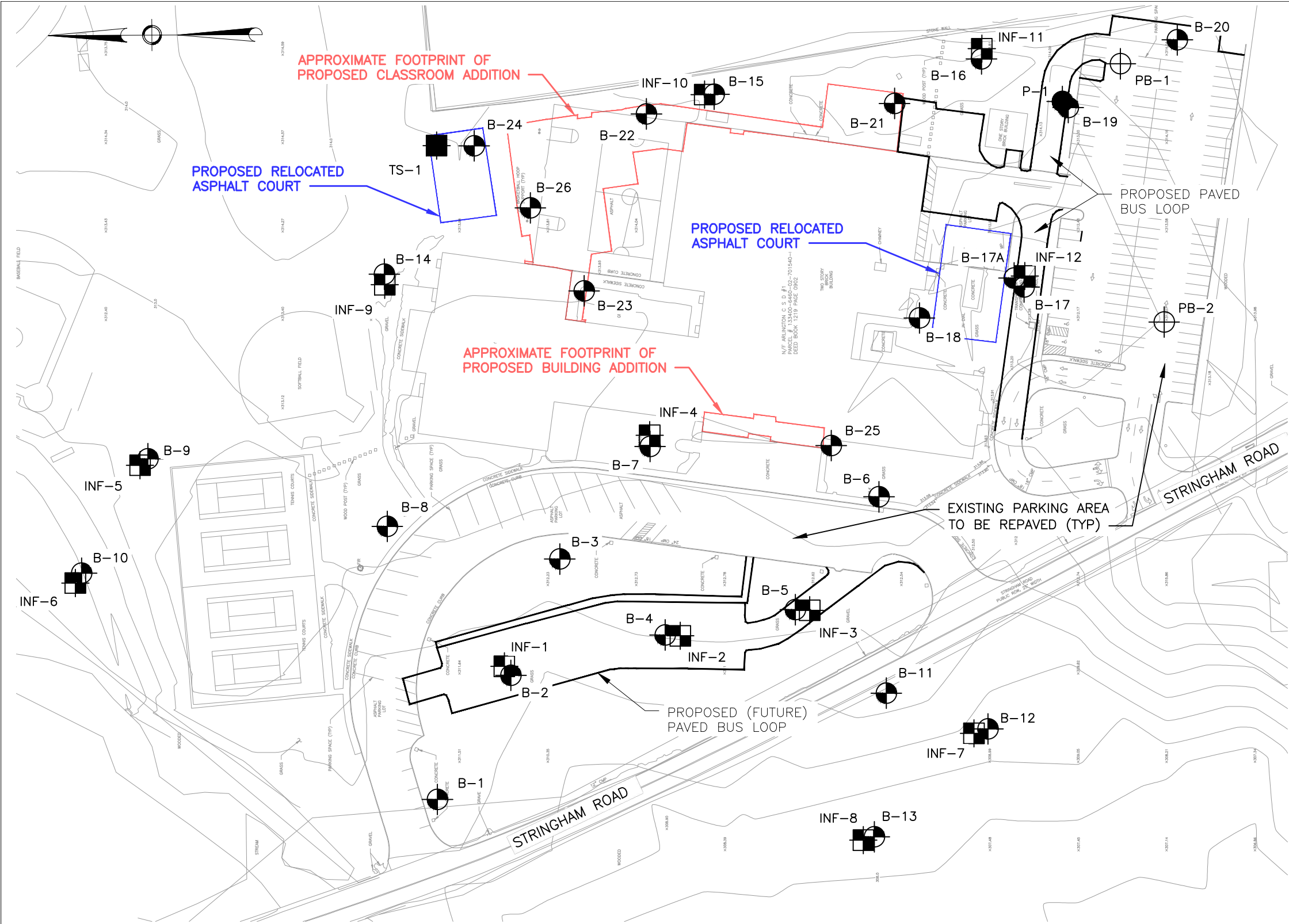
3.28 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 31 20 00

GEOTECHNICAL BORING MAPS AND LOGS

Appendix to Project Manual Section 31 20 00, EARTH MOVING



LEGEND

B-26

APPROXIMATE BORING LOCATION

PB-2

APPROXIMATE PAVEMENT BORING LOCATION

P-1

APPROXIMATE PROBE LOCATION

INF-12

APPROXIMATE INFILTRATION TEST LOCATION

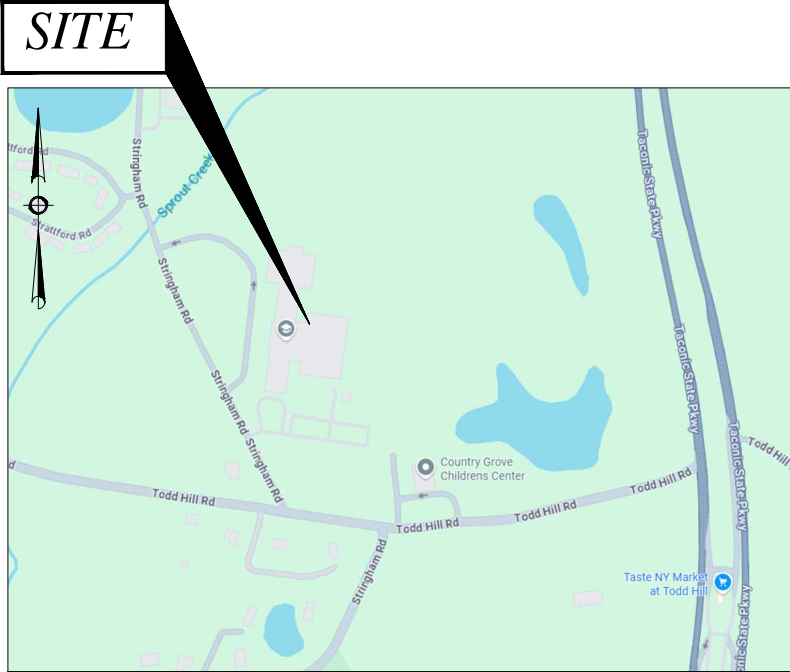
TS-1

APPROXIMATE TOPSOIL TEST LOCATION

NOTES

1. PLAN BASED ON A TOPOGRAPHIC SURVEY PROVIDED BY TECTONIC ENGINEERING ENTITLED "BOUNDARY & TOPOGRAPHIC SURVEY", DRAWING NO. SU-101 THROUGH SU-106, DATED 08/08/25, AND A DRAWING PROVIDED BY THE CLIENT ENTITLED "SITE LAYOUT PLAN - AREA A" DRAWING NO. KC120, DATED 03/18/2025.

2. ALL OF THE TEST LOCATIONS WERE FIELD LOCATED BY TECTONIC, AT CLIENT DESIGNATED LOCATIONS, AND SHOULD BE CONSIDERED APPROXIMATE.



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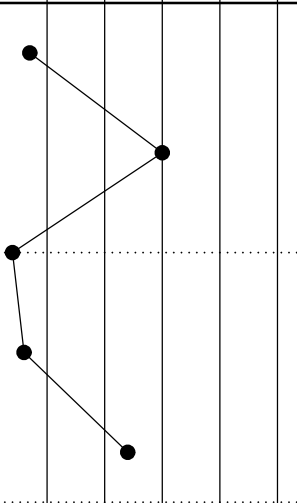
SUBSURFACE INVESTIGATION PLAN

PROPOSED SITE IMPROVEMENTS
LAGRANGE MIDDLE SCHOOL
110 STRINGHAM ROAD, HAMLET OF LAGRANGEVILLE
TOWN OF LAGRANGE, DUTCHESS COUNTY, NEW YORK

Date 08/22/2025	Work Order 13018.02	Drawing No. FIGURE 1	Rev 0
Scale 1" = 100'			

APPENDIX I

CLIENT: Arlington Central School District			GROUND WATER	DATE	TIME	DEPTH	INSPECTOR: Ryan Villa		
CONTRACTOR: Core Down Drilling LLC							DRILLER: Kevin Nash		
METHOD OF ADVANCING BORING	DIA.	DEPTH					SURFACE ELEVATION: 311.5		
POWER AUGER:	3 1/4"	0 TO 8'		MON. WELL ☐ YES ☒ NO			DATUM: See Remarks		
ROT. DRILL:		TO	SCREEN DEPTH: --- TO ---		DATE START: 5/13/25				
CASING:		TO	WEATHER: Clear TEMP: 60° F		DATE FINISH: 5/13/25				
DIAMOND CORE:		TO	DEPTH TO ROCK: Not Encountered'		UNCONFINED COMPRESS. STRENGTH ● (TONS/FT)			FT.)	
Geoprobe 6712DT with Automatic Hammer			*CHANGES IN STRATA ARE INFERRED		1	2	3		4

DEPTH (FT.)	N OR MIN./FT.	PENETRATION RESISTANCE (BL/6 IN.)	SAMPLES				UNIFIED SOIL CLASS.	DESCRIPTION OF MATERIAL	LITHOLOGY*	STANDARD PENETRATION (BLOWS/FT.)			ELEVATION (FT.)							
			SAMPLE NUMBER	RECOV.		MOISTURE				PLASTIC LIMIT % X-----	WATER CONTENT % -----X-----	LIQUID LIMIT % -----△-----								
				LENGTH (IN.)	RQD (%)															
1	7	1	S-1	12		M	SM	3" Topsoil-like material												
2		2																		
3	30	5																		
4		13	S-2	12		M	SM	Bwn c-f SAND, and Silt, little c-f Gravel (FILL)												
5	4	17																		
6		18																		
7		12	S-3	12		W	SM	Bwn c-f SAND, some Silt, little c-f Gravel												
8	4	10																		
9		6																		
10		2	S-4	12		W	SM	6" Bwn c-f SAND, some Silt, some c-f Gravel												
11	4	2																		
12		2																		
13		1	S-5	14		W	SM	6" Gy c-f SAND, and Silt												
14	6	3																		
15		3																		
16		3	S-5	14		W	SM	Gy c-f SAND, and Silt, trace f Gravel												
17	6	6																		
18		11																		
19		13	S-5	14		W	SM	Bwn-gy c-f SAND, some c-f Gravel, little Silt												
20	24	12																		
21																				
22																				
23																				
24																				
25																				

REMARKS: Elevations are estimated based on topographic survey prepared by Tectonic, entitled "Boundary & Topographic Survey, Lagrange Middle School, 110 Stringham Road, Town of Lagrange, County of Dutchess, State of New York", dated



PROJECT No. 13018.02

PROJECT: Arlington CSD - Lagrange
Middle School

LOCATION: LaGrangeville, NY

BORING No. B-2

SHEET No. 1 of 1

CLIENT: Arlington Central School District

CONTRACTOR: Core Down Drilling LLC

METHOD OF ADVANCING BORING

DIA.

DEPTH

GROUND
WATER

DATE

TIME

DEPTH

INSPECTOR: Ryan Villa

DRILLER: Kevin Nash

SURFACE ELEVATION: 311.5

POWER AUGER: 3 1/4" 0 TO 8'

MON. WELL ☐ YES ☒ NO

DATUM: See Remarks

ROT. DRILL: TO

SCREEN DEPTH: --- TO ---

DATE START: 5/13/25

CASING: TO

WEATHER: Clear TEMP: 60° F

DATE FINISH: 5/13/25

DIAMOND CORE: TO

DEPTH TO ROCK: Not Encountered'

Geoprobe 6712DT with Automatic Hammer

*CHANGES IN STRATA ARE INFERRED

UNCONFINED COMPRESS. STRENGTH
(TONS/FT)

1 2 3 4 5

PLASTIC LIMIT % WATER CONTENT % LIQUID LIMIT %

X --- --- --- ---

10 20 30 40 50

STANDARD PENETRATION (BLOWS/FT.)

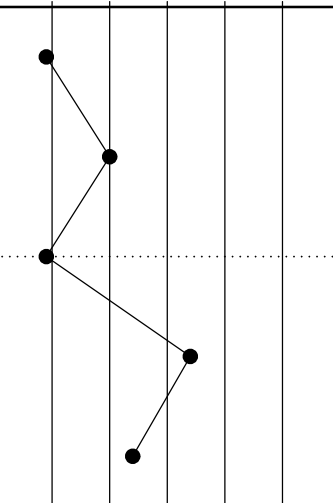
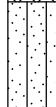
10 20 30 40 50

ELEVATION (FT.)

DEPTH (FT.)	N OR MIN./FT.	PENETRATION RESISTANCE (BL/6 IN.)	SAMPLES				UNIFIED SOIL CLASS.	DESCRIPTION OF MATERIAL	LITHOLOGY*	PLASTIC LIMIT %			WATER CONTENT %			LIQUID LIMIT %			ELEVATION (FT.)			
			SAMPLE NUMBER	RECOV.		MOISTURE				X	O	X	O	X	O	X	O					
				LENGTH (IN.)	RQD (%)													10		20	30	40
										STANDARD PENETRATION (BLOWS/FT.)												
1	8	2 4 4 5	S-1	5		M	SM	2" Topsoil-like material Bwn c-f SAND, little Silt, trace c-f Gravel (FILL)														
2																						
3	3	2 2 1 3	S-2	8		M	SM	Bwn c-f SAND, little c-f Gravel, little Silt														
4																						
5	5	3 3 2 6	S-3	12		W	SM	Bwn c-f SAND, little Silt, trace c-f Gravel										306.5				
6																						
7	21	8 10 11 9	S-4	10		W	SP-SM	Bwn c-f SAND, and c-f Gravel, trace Silt														
8																						
9	24	9 12 12 9	S-5	12		W	SP-SM	Same														
10																		301.5				
11								End of Boring at 10'														
12																						
13																						
14																						
15																			296.5			
16																						
17																						
18																						
19																						
20																			291.5			
21																						
22																						
23																						
24																						
25																			286.5			

REMARKS: Elevations are estimated based on topographic survey prepared by Tectonic, entitled "Boundary & Topographic Survey, Lagrange Middle School, 110 Stringham Road, Town of Lagrange, County of Dutchess, State of New York", dated

CLIENT: Arlington Central School District			GROUND WATER	DATE	TIME	DEPTH	INSPECTOR: Ryan Villa		
CONTRACTOR: Core Down Drilling LLC							DRILLER: Kevin Nash		
METHOD OF ADVANCING BORING	DIA.	DEPTH					SURFACE ELEVATION: 312.5		
POWER AUGER:	3 1/4"	0 TO 8'		MON. WELL	☐ YES	☒ NO	DATUM: See Remarks		
ROT. DRILL:		TO	SCREEN DEPTH: ---		TO ---	DATE START: 5/13/25			
CASING:		TO	WEATHER: Clear		TEMP: 60° F	DATE FINISH: 5/13/25			
DIAMOND CORE:		TO	DEPTH TO ROCK: Not Encountered'		UNCONFINED COMPRESS. STRENGTH (TONS/FT) 			(F.T.)	
Geoprobe 6712DT with Automatic Hammer			*CHANGES IN STRATA ARE INFERRED						
					1	2	3	4	5

DEPTH (FT.)	N OR MIN./FT.	PENETRATION RESISTANCE (BL/6 IN.)	SAMPLES				UNIFIED SOIL CLASS.	DESCRIPTION OF MATERIAL	LITHOLOGY*	PLASTIC LIMIT %			WATER CONTENT %			LIQUID LIMIT %			ELEVATION (FT.)
			SAMPLE NUMBER	RECOV.		MOISTURE				X	10	20	30	X	40	50	Δ		
				LENGTH (IN.)	RQD (%)														
1	9	1	S-1	16		M	SM	3" Topsoil-like material Bwn c-f SAND, some c-f Gravel, little Silt (FILL)											
2		3																	
3	20	6	S-2	12		M	SM	Bwn c-f SAND, some Silt, little f Gravel											
4		11																	
5	9	12	S-3	12		M	SM	Same											
6		8																	
7	34	7	S-4	1		W	GP	Bwn c GRAVEL, trace c-f Sand, trace Silt (pieces of gravel stuck in shoe)											
8		6																	
9	24	4	S-5	14		W	GP-GM	Bwn c-f GRAVEL, and c-f Sand, trace Silt											
10		5																	
11		15						End of Boring at 10'											
12		16																	
13		18																	
14		18																	
15		14																	
16		13																	
17		11																	
18		9																	
19																			
20																			
21																			
22																			
23																			
24																			
25																			

REMARKS: Elevations are estimated based on topographic survey prepared by Tectonic, entitled "Boundary & Topographic Survey, Lagrange Middle School, 110 Stringham Road, Town of Lagrange, County of Dutchess, State of New York", dated



PROJECT No. **13018.02**
PROJECT: **Arlington CSD - Lagrange Middle School**
LOCATION: **LaGrangeville, NY**

BORING No. B-4

SHEET No. 1 of 1

CLIENT: Arlington Central School District				GROUND WATER	DATE	TIME	DEPTH	INSPECTOR: Ryan Villa	
CONTRACTOR: Core Down Drilling LLC								DRILLER: Kevin Nash	
METHOD OF ADVANCING BORING	DIA.	DEPTH						SURFACE ELEVATION: 312.0	
POWER AUGER:	3 1/4"	0	TO 8'		MON. WELL	☐ YES	☒ NO	DATUM: See Remarks	
ROT. DRILL:			TO	SCREEN DEPTH: --- TO ---			DATE START: 5/13/25		
CASING:			TO	WEATHER: Clear TEMP: 60° F			DATE FINISH: 5/13/25		
DIAMOND CORE:			TO	DEPTH TO ROCK: Not Encountered'			UNCONFINED COMPRESS. STRENGTH (TONS/FT)		
Geoprobe 6712DT with Automatic Hammer				*CHANGES IN STRATA ARE INFERRED			1 2 3 4 5		

DEPTH (FT.)	N OR MIN./FT.	PENETRATION RESISTANCE (BL/6 IN.)	SAMPLES				UNIFIED SOIL CLASS.	DESCRIPTION OF MATERIAL	LITHOLOGY*	PLASTIC LIMIT %			WATER CONTENT %			LIQUID LIMIT %			ELEVATION (FT.)
			SAMPLE NUMBER	RECOV.		MOISTURE				STANDARD PENETRATION (BLOWS/FT.)									
				LENGTH (IN.)	RQD (%)														
1	11	4	S-1	6		M	SM	3" Topsoil-like material		10	20	30	40	50					
2		7						Bwn c-f SAND, and c-f Gravel, little Silt (FILL)											
3	7	4	S-2	14		M	SM	Bwn c-f SAND, little Silt, trace c-f Gravel											
4		7																	
5	31	10	S-3	12		W	SM	Bwn c-f SAND, some c-f Gravel, little Silt											
6		13																307.0	
7	27	16	S-4	12		W	GP-GM	Bwn c-f GRAVEL, and c-f Sand, trace Silt											
8		12																	
9	17	15	S-5	10		W	GP-GM	Same											
10		19																302.0	
11		14																	
12																			
13																			
14																			
15																	297.0		
16																			
17																			
18																			
19																			
20																	292.0		
21																			
22																			
23																			
24																			
25																	287.0		

REMARKS: Elevations are estimated based on topographic survey prepared by Tectonic, entitled "Boundary & Topographic Survey, Lagrange Middle School, 110 Stringham Road, Town of Lagrange, County of Dutchess, State of New York", dated



PROJECT No. 13018.02

PROJECT: Arlington CSD - Lagrange
Middle School

LOCATION: LaGrangeville, NY

BORING No. B-5

SHEET No. 1 of 1

CLIENT: Arlington Central School District

CONTRACTOR: Core Down Drilling LLC

METHOD OF ADVANCING BORING

DIA.

DEPTH

GROUND
WATER

DATE

TIME

DEPTH

INSPECTOR: Ryan Villa

DRILLER: Kevin Nash

SURFACE ELEVATION: 312.5

POWER AUGER: 3 1/4" 0 TO 8'

MON. WELL ☐ YES ☒ NO

DATUM: See Remarks

ROT. DRILL: TO

SCREEN DEPTH: --- TO ---

DATE START: 5/13/25

CASING: TO

WEATHER: Clear TEMP: 60° F

DATE FINISH: 5/13/25

DIAMOND CORE: TO

DEPTH TO ROCK: Not Encountered'

Geoprobe 6712DT with Automatic Hammer

*CHANGES IN STRATA ARE INFERRED

UNCONFINED COMPRESS. STRENGTH
(TONS/FT)

1 2 3 4 5

PLASTIC LIMIT % WATER CONTENT % LIQUID LIMIT %

X --- O --- A ---

10 20 30 40 50

STANDARD PENETRATION (BLOWS/FT.)

10 20 30 40 50

ELEVATION (FT.)

DEPTH (FT.)	N OR MIN./FT.	PENETRATION RESISTANCE (BL/6 IN.)	SAMPLES				UNIFIED SOIL CLASS.	DESCRIPTION OF MATERIAL	LITHOLOGY*	PLASTIC LIMIT %			WATER CONTENT %			LIQUID LIMIT %			ELEVATION (FT.)
			SAMPLE NUMBER	RECOV.		MOISTURE				X	---	---	X	---	---	X	---	---	
				LENGTH (IN.)	RQD (%)														
STANDARD PENETRATION (BLOWS/FT.) ●																			
1	9	2 3 6	S-1	8		M	GM	3" Topsoil-like material Bwn c-f GRAVEL, and c-f Sand, little Silt (FILL)		10	20	30	40	50					
2		11																	
3	27	10 15 12	S-2	12		M	GM	Bwn c-f GRAVEL, and c-f Sand, little Silt											
4		14																	
5	25	13 13 12	S-3	10		M	SM	Bwn c-f SAND, little c-f Gravel, little Silt										307.5	
6		9																	
7	17	8 7 10	S-4	12		W	SP-SM	Bwn c-f SAND, and c-f Gravel, trace Silt											
8		10																	
9	20	12 9 11	S-5	12		W	GP-GM	Bwn c-f SAND, and c-f Gravel, trace Silt											
10		9																302.5	
11								End of Boring at 10'											
12																			
13																			
14																			
15																			297.5
16																			
17																			
18																			
19																			
20																			292.5
21																			
22																			
23																			
24																			
25																			287.5

REMARKS: Elevations are estimated based on topographic survey prepared by Tectonic, entitled "Boundary & Topographic Survey, Lagrange Middle School, 110 Stringham Road, Town of Lagrange, County of Dutchess, State of New York", dated

BORING LOG 13018.02 MIDDLE SCHOOL.GPJ TECTONIC.ENG.GDT 8/25/25

Tectonic PROJECT No. 13018.02 PROJECT: Arlington CSD - Lagrange Middle School LOCATION: LaGrangeville, NY										BORING No. B-6									
										SHEET No. 1 of 1									
										CLIENT: Arlington Central School District					GROUND WATER	DATE	TIME	DEPTH	INSPECTOR: Ryan Villa
CONTRACTOR: Core Down Drilling LLC								DRILLER: Kevin Nash											
METHOD OF ADVANCING BORING		DIA.	DEPTH					SURFACE ELEVATION: 313.5											
POWER AUGER:		3 1/4"	0	TO 8'	MON. WELL ☐ YES ☒ NO		DATUM: See Remarks												
ROT. DRILL:				TO	SCREEN DEPTH: --- TO ---		DATE START: 5/13/25												
CASING:				TO	WEATHER: Clear TEMP: 60° F		DATE FINISH: 5/13/25												
DIAMOND CORE:				TO	DEPTH TO ROCK: Not Encountered'		UNCONFINED COMPRESS. STRENGTH (TONS/FT) ● 1 2 3 4 5 PLASTIC LIMIT % WATER CONTENT % LIQUID LIMIT % X --- ⊗ --- Δ 10 20 30 40 50 STANDARD PENETRATION (BLOWS/FT.) ● 10 20 30 40 50												
Geoprobe 6712DT with Automatic Hammer					*CHANGES IN STRATA ARE INFERRED														
DEPTH (FT.)	N OR MIN./FT.	PENETRATION RESISTANCE (BLU/6 IN.)	SAMPLE NUMBER	RECOV. LENGTH (IN.)	RQD (%)	MOISTURE	UNIFIED SOIL CLASS.	DESCRIPTION OF MATERIAL	LITHOLOGY*	ELEVATION (FT.)									
1	12	1 5 7	S-1	6		M	SM	3" Topsoil-like material Bwn c-f SAND, little c-f Gravel, little Silt (FILL)											
2		10																	
3	9	7 5 4	S-2	3		M	GM	Bwn c-f GRAVEL, and c-f Sand, little Silt											
4		4																	
5	22	8 10 12	S-3	14		M	SM	Bwn c-f SAND, little Silt, trace c-f Gravel		308.5									
6		10																	
7	23	13 14 9	S-4	14		W	GM	Bwn c-f GRAVEL, and c-f Sand, little Silt											
8		9																	
9	20	10 10 10	S-5	8		W	SP-SM	Bwn c-f SAND, and c-f Gravel, trace Silt		303.5									
10		8																	
11								End of Boring at 10'											
12																			
13																			
14																			
15										298.5									
16																			
17																			
18																			
19																			
20										293.5									
21																			
22																			
23																			
24																			
25										288.5									
REMARKS: Elevations are estimated based on topographic survey prepared by Tectonic, entitled "Boundary & Topographic Survey, Lagrange Middle School, 110 Stringham Road, Town of Lagrange, County of Dutchess, State of New York", dated																			

CLIENT: Arlington Central School District				GROUND WATER	DATE	TIME	DEPTH	INSPECTOR: Ryan Villa	
CONTRACTOR: Core Down Drilling LLC								DRILLER: Kevin Nash	
METHOD OF ADVANCING BORING	DIA.	DEPTH						SURFACE ELEVATION: 312.5	
POWER AUGER:	3 1/4"	0	TO 8'		MON. WELL ☐ YES ☒ NO	DATUM: See Remarks			
ROT. DRILL:			TO	SCREEN DEPTH: ---	TO	---	DATE START: 5/13/25		
CASING:			TO	WEATHER: Clear	TEMP:	60° F	DATE FINISH: 5/13/25		
DIAMOND CORE:			TO	DEPTH TO ROCK: Not Encountered'			UNCONFINED COMPRESS. STRENGTH ● (TONS/FT)		(FT)
Geoprobe 6712DT with Automatic Hammer				*CHANGES IN STRATA ARE INFERRED		1 2 3 4 5			

DEPTH (FT.)	N OR MIN./FT.	PENETRATION RESISTANCE (BL/6 IN.)	SAMPLES				UNIFIED SOIL CLASS.	DESCRIPTION OF MATERIAL	LITHOLOGY*	PLASTIC LIMIT %			WATER CONTENT %			LIQUID LIMIT %			ELEVATION (FT.)
			SAMPLE NUMBER	RECOV.		MOISTURE				X	20	30	X	40	50	X	40	50	
				LENGTH (IN.)	RQD (%)														
STANDARD PENETRATION (BLOWS/FT.)											●								
1	10	1	S-1	12		M	SM	3" Topsoil-like material Bwn c-f SAND, some c-f Gravel, some Silt (FILL)											
2		4																	
3	23	13	S-2	16		M	SM	Bwn c-f SAND, some c-f Gravel, little Silt											
4		14																	
5	5	2	S-3	6		M	SM	Bwn c-f SAND, some Silt, trace f Gravel											
6		3																	
7	21	9	S-4	14		W	SM	Gy-bwn c-f SAND, and c-f Gravel, little Silt											
8		12																	
9	16	11	S-5	12		W	GP-GM	Bwn c-f GRAVEL, and c-f Sand, trace Silt											
10		9																	
11								End of Boring at 10'											
12																			
13																			
14																			
15																			
16																			
17																			
18																			
19																			
20																			
21																			
22																			
23																			
24																			
25																			

REMARKS: Elevations are estimated based on topographic survey prepared by Tectonic, entitled "Boundary & Topographic Survey, Lagrange Middle School, 110 Stringham Road, Town of Lagrange, County of Dutchess, State of New York", dated

BORING LOG 13018.02 MIDDLE SCHOOL.GPJ TECTONIC.ENG.GDT 8/21/25

Tectonic PROJECT No. 13018.02 PROJECT: Arlington CSD - Lagrange Middle School LOCATION: LaGrangeville, NY										BORING No. B-11									
										SHEET No. 1 of 1									
										CLIENT: Arlington Central School District					GROUND WATER	DATE	TIME	DEPTH	INSPECTOR: Ryan Villa
CONTRACTOR: Core Down Drilling LLC								DRILLER: Kevin Nash											
METHOD OF ADVANCING BORING		DIA.	DEPTH					SURFACE ELEVATION: 311.5											
POWER AUGER:		3 1/4"	0	TO 8'	MON. WELL ☐ YES ☒ NO		DATUM: See Remarks												
ROT. DRILL:				TO	SCREEN DEPTH: --- TO ---		DATE START: 5/14/25												
CASING:				TO	WEATHER: Overcast TEMP: 60° F		DATE FINISH: 5/14/25												
DIAMOND CORE:				TO	DEPTH TO ROCK: Not Encountered'		UNCONFINED COMPRESS. STRENGTH (TONS/FT) ● 1 2 3 4 5 PLASTIC LIMIT % WATER CONTENT % LIQUID LIMIT % X --- ⊗ --- Δ 10 20 30 40 50 STANDARD PENETRATION (BLOWS/FT.) ● 10 20 30 40 50												
Geoprobe 6712DT with Automatic Hammer					*CHANGES IN STRATA ARE INFERRED														
DEPTH (FT.)	N OR MIN./FT.	PENETRATION RESISTANCE (BLU/6 IN.)	SAMPLE NUMBER	RECOV. LENGTH (IN.)	RQD (%)	MOISTURE	UNIFIED SOIL CLASS.	DESCRIPTION OF MATERIAL	LITHOLOGY*	ELEVATION (FT.)									
1	4	WOH 2 2 2	S-1	10		M	GM	1" Topsoil-like material Bwn c-f GRAVEL, some c-f Sand, some Silt (FILL)											
2																			
3	11	3 4 7	S-2	6		M	GM	Bwn c-f GRAVEL, and c-f Sand, little Silt											
4		8																	
5	23	8 10 13	S-3	10		W	GM	Same		306.5									
6		12																	
7	19	10 9 10	S-4	2		W	GP-GM	Bwn c-f GRAVEL, and c-f Sand, trace Silt											
8		10																	
9	13	8 8 5	S-5	18		W	GP-GM	Same											
10		8								301.5									
11								End of Boring at 10'											
12																			
13																			
14																			
15										296.5									
16																			
17																			
18																			
19																			
20										291.5									
21																			
22																			
23																			
24																			
25										286.5									
REMARKS: Elevations are estimated based on topographic survey prepared by Tectonic, entitled "Boundary & Topographic Survey, Lagrange Middle School, 110 Stringham Road, Town of Lagrange, County of Dutchess, State of New York", dated																			

BORING LOG 13018.02 MIDDLE SCHOOL.GPJ TECTONIC.ENG.GDT 8/21/25

Tectonic PROJECT No. 13018.02 PROJECT: Arlington CSD - Lagrange Middle School LOCATION: LaGrangeville, NY										BORING No. B-12									
										SHEET No. 1 of 1									
										CLIENT: Arlington Central School District					GROUND WATER	DATE	TIME	DEPTH	INSPECTOR: Ryan Villa
CONTRACTOR: Core Down Drilling LLC								DRILLER: Kevin Nash											
METHOD OF ADVANCING BORING		DIA.	DEPTH					SURFACE ELEVATION: 309.5											
POWER AUGER:		3 1/4"	0	TO 8'	MON. WELL ☐ YES ☒ NO		DATUM: See Remarks												
ROT. DRILL:				TO	SCREEN DEPTH: --- TO ---		DATE START: 5/14/25												
CASING:				TO	WEATHER: Overcast TEMP: 60° F		DATE FINISH: 5/14/25												
DIAMOND CORE:				TO	DEPTH TO ROCK: Not Encountered'		UNCONFINED COMPRESS. STRENGTH (TONS/FT) ● 1 2 3 4 5 PLASTIC LIMIT % WATER CONTENT % LIQUID LIMIT % X --- ⊗ --- Δ 10 20 30 40 50 STANDARD PENETRATION (BLOWS/FT.) ● 10 20 30 40 50												
Geoprobe 6712DT with Automatic Hammer					*CHANGES IN STRATA ARE INFERRED														
DEPTH (FT.)	N OR MIN./FT.	PENETRATION RESISTANCE (BLU/6 IN.)	SAMPLE NUMBER	RECOV. LENGTH (IN.)	RQD (%)	MOISTURE	UNIFIED SOIL CLASS.	DESCRIPTION OF MATERIAL	LITHOLOGY*	ELEVATION (FT.)									
1	8	2 4 4 4	S-1	10		M	GM	1" Topsoil-like material Bwn c-f GRAVEL, and c-f Sand, little Silt (FILL)											
2		6																	
3	9	7 5 4 4	S-2	6		M	GM	Bwn c-f GRAVEL, and c-f Sand, little Silt											
4		4																	
5	17	6 9 8 8	S-3	12		W	GP-GM	Bwn c-f GRAVEL, and c-f Sand, trace Silt		304.5									
6		8																	
7	17	10 9 8 9	S-4	10		W	GP-GM	Same											
8		9																	
9	22	10 10 12 15	S-5	10		W	GP-GM	Same		299.5									
10																			
11								End of Boring at 10'											
12																			
13																			
14																			
15										294.5									
16																			
17																			
18																			
19																			
20										289.5									
21																			
22																			
23																			
24																			
25										284.5									
REMARKS: Elevations are estimated based on topographic survey prepared by Tectonic, entitled "Boundary & Topographic Survey, Lagrange Middle School, 110 Stringham Road, Town of Lagrange, County of Dutchess, State of New York", dated																			

BORING LOG 13018.02 MIDDLE SCHOOL.GPJ TECTONIC.ENG.GDT 8/21/25

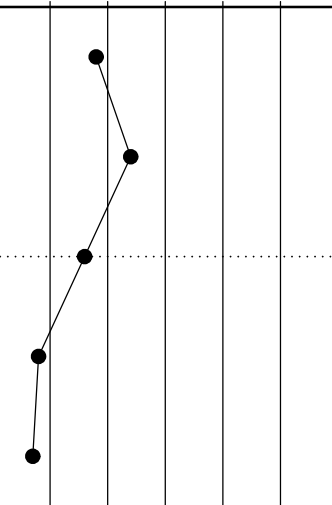
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										PROJECT: Arlington CSD - Lagrange Middle School							
										LOCATION: LaGrangeville, NY				SHEET No. 1 of 1			
CLIENT: Arlington Central School District								GROUND WATER	DATE	TIME	DEPTH	INSPECTOR: Ryan Villa					
CONTRACTOR: Core Down Drilling LLC												DRILLER: Kevin Nash					
METHOD OF ADVANCING BORING				DIA.	DEPTH							SURFACE ELEVATION: 308.5					
POWER AUGER:				3 1/4"	0	TO	8'	MON. WELL ☐ YES ☒ NO				DATUM: See Remarks					
ROT. DRILL:						TO		SCREEN DEPTH: --- TO ---				DATE START: 5/14/25					
CASING:						TO		WEATHER: Overcast TEMP: 60° F				DATE FINISH: 5/14/25					
DIAMOND CORE:						TO		DEPTH TO ROCK: Not Encountered'				UNCONFINED COMPRESS. STRENGTH (TONS/FT) ● 1 2 3 4 5 PLASTIC LIMIT % WATER CONTENT % LIQUID LIMIT % × --- ⊗ --- △ 10 20 30 40 50 STANDARD PENETRATION (BLOWS/FT.) ● 10 20 30 40 50					
Geoprobe 6712DT with Automatic Hammer								*CHANGES IN STRATA ARE INFERRED									
DEPTH (FT.)	N OR MIN./FT.	PENETRATION RESISTANCE (BLU/6 IN.)	SAMPLE NUMBER	RECOV. LENGTH (IN.)	RQD (%)	MOISTURE	UNIFIED SOIL CLASS.	DESCRIPTION OF MATERIAL	LITHOLOGY*	ELEVATION (FT.)							
1	0	1 WOH WOH	S-1	12		M	ML	1" Topsoil-like material									
2		1						Bwn SILT, little m-f Sand, trace roots									
3	16	4 6 10 8	S-2	18		M	SM	Gy-bwn c-f SAND, some c-f Gravel, some Silt									
4		9															
5	24	10 14 12	S-3	12		W	GM	Bwn c-f GRAVEL, and c-f Sand, little Silt									
6		9								303.5							
7	21	11 10 11	S-4	1		W	GP-GM	Bwn c-f GRAVEL, and c-f Sand, trace Silt (c Gravel stuck in shoe)									
8		11															
9	28	13 15 15	S-5	12		W	SM	Bwn c-f SAND, some c-f Gravel, little Silt									
10														298.5			
11								End of Boring at 10'									
12																	
13																	
14																	
15										293.5							
16																	
17																	
18																	
19																	
20										288.5							
21																	
22																	
23																	
24																	
25										283.5							
REMARKS: Elevations are estimated based on topographic survey prepared by Tectonic, entitled "Boundary & Topographic Survey, Lagrange Middle School, 110 Stringham Road, Town of Lagrange, County of Dutchess, State of New York", dated																	

PROJECT No. **13018.02**
 PROJECT: **Arlington CSD - Lagrange Middle School**
 LOCATION: **LaGrangeville, NY**

BORING No. B-14

SHEET No. 1 of 1

CLIENT: Arlington Central School District			GROUND WATER	DATE	TIME	DEPTH	INSPECTOR: Ryan Villa				
CONTRACTOR: Core Down Drilling LLC							DRILLER: Kevin Nash				
METHOD OF ADVANCING BORING	DIA.	DEPTH					SURFACE ELEVATION: 314.0				
POWER AUGER:	3 1/4"	0 TO 8'		MON. WELL	☐ YES	☒ NO	DATUM: See Remarks				
ROT. DRILL:		TO	SCREEN DEPTH: --- TO ---			DATE START: 5/14/25					
CASING:		TO	WEATHER: Overcast TEMP: 60° F			DATE FINISH: 5/14/25					
DIAMOND CORE:		TO	DEPTH TO ROCK: Not Encountered'			UNCONFINED COMPRESS. STRENGTH ● (TONS/FT)					
Geoprobe 6712DT with Automatic Hammer			*CHANGES IN STRATA ARE INFERRED			1	2	3	4	5	FT.)

DEPTH (FT.)	N OR MIN./FT.	PENETRATION RESISTANCE (BL/6 IN.)	SAMPLES			UNIFIED SOIL CLASS.	DESCRIPTION OF MATERIAL	LITHOLOGY*	STANDARD PENETRATION (BLOWS/FT.)			ELEVATION (FT.)	
			SAMPLE NUMBER	RECOV.					MOISTURE	PLASTIC LIMIT % X-----X	WATER CONTENT % -----X-----		LIQUID LIMIT % -----Δ-----
				LENGTH (IN.)	RQD (%)								
1	18	3	S-1	12		M	SM						
2		7											
3	24	11	S-2	12		M	SM						
4		12											
5	16	15	S-3	6		M	GM				309.0		
6		9											
7	8	7	S-4	6		W	GP-GM						
8		4											
9	7	4	S-5	12		W	GP-GM						
10		3											
11		3									304.0		
12													
13													
14													
15											299.0		
16													
17													
18													
19													
20											294.0		
21													
22													
23													
24													
25											289.0		

REMARKS: Elevations are estimated based on topographic survey prepared by Tectonic, entitled "Boundary & Topographic Survey, Lagrange Middle School, 110 Stringham Road, Town of Lagrange, County of Dutchess, State of New York", dated

BORING LOG 13018.02 MIDDLE SCHOOL.GPJ TECTONIC.ENG.GDT 8/21/25

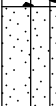
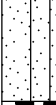
Tectonic PROJECT No. 13018.02 PROJECT: Arlington CSD - Lagrange Middle School LOCATION: LaGrangeville, NY										BORING No. B-15									
										SHEET No. 1 of 1									
										CLIENT: Arlington Central School District					GROUND WATER	DATE	TIME	DEPTH	INSPECTOR: Ryan Villa
CONTRACTOR: Core Down Drilling LLC								DRILLER: Kevin Nash											
METHOD OF ADVANCING BORING		DIA.	DEPTH					SURFACE ELEVATION: 314.0											
POWER AUGER:		3 1/4"	0	TO	8'	MON. WELL ☐ YES ☒ NO		DATUM: See Remarks											
ROT. DRILL:				TO		SCREEN DEPTH: --- TO ---		DATE START: 5/14/25											
CASING:				TO		WEATHER: Clear TEMP: 60° F		DATE FINISH: 5/14/25											
DIAMOND CORE:				TO		DEPTH TO ROCK: Not Encountered'		UNCONFINED COMPRESS. STRENGTH (TONS/FT)											
Geoprobe 6712DT with Automatic Hammer					*CHANGES IN STRATA ARE INFERRED		1 2 3 4 5		ELEVATION (FT.)										
DEPTH (FT.)	N OR MIN./FT.	PENETRATION RESISTANCE (BLU/6 IN.)	SAMPLES			UNIFIED SOIL CLASS.	DESCRIPTION OF MATERIAL	LITHOLOGY*			PLASTIC LIMIT %	WATER CONTENT %	LIQUID LIMIT %						
			SAMPLE NUMBER	RECOV.							MOISTURE	X	⊗	Δ					
				LENGTH (IN.)	RQD (%)														
STANDARD PENETRATION (BLOWS/FT.)																			
10 20 30 40 50																			
1	9	3	S-1	12		M	SM	3" Topsoil-like material Bwn c-f SAND, some Silt, little c-f Gravel (FILL)		●	314.0								
2		3																	
3	6	5	S-2	12		M	SM	Bwn c-f SAND, little c-f Gravel, little Silt (FILL)		●	309.0								
4		3																	
5	16	8	S-3	14		M	GP-GM	Bwn c-f GRAVEL, and c-f Sand, trace Silt		●	304.0								
6		7																	
7	14	8	S-4	14		W	GP-GM	Same		●	304.0								
8		7																	
9	13	8	S-5	12		W	GP-GM	Same		●	304.0								
10		6																	
11		7						End of Boring at 10'		●	299.0								
12		8																	
13																			
14																			
15																			
16																			
17																			
18																			
19																			
20																			
21																			
22																			
23																			
24																			
25																			
REMARKS: Elevations are estimated based on topographic survey prepared by Tectonic, entitled "Boundary & Topographic Survey, Lagrange Middle School, 110 Stringham Road, Town of Lagrange, County of Dutchess, State of New York", dated																			

CLIENT: Arlington Central School District			GROUND WATER	DATE	TIME	DEPTH	INSPECTOR: Ryan Villa	
CONTRACTOR: Core Down Drilling LLC							DRILLER: Kevin Nash	
METHOD OF ADVANCING BORING	DIA.	DEPTH					SURFACE ELEVATION: 314.0	
POWER AUGER:	3 1/4"	0 TO 8'		MON. WELL ☐ YES ☒ NO			DATUM: See Remarks	
ROT. DRILL:		TO	SCREEN DEPTH: --- TO ---			DATE START: 5/14/25		
CASING:		TO	WEATHER: Rain TEMP: 55° F			DATE FINISH: 5/14/25		
DIAMOND CORE:		TO	DEPTH TO ROCK: Not Encountered'			UNCONFINED COMPRESS. STRENGTH (TONS/FT)		
Geoprobe 6712DT with Automatic Hammer			*CHANGES IN STRATA ARE INFERRED		1 2 3 4 5		FT.)	

DEPTH (FT.)	N OR MIN./FT.	PENETRATION RESISTANCE (BL/6 IN.)	SAMPLES				UNIFIED SOIL CLASS.	DESCRIPTION OF MATERIAL	LITHOLOGY*	UNCONFINED COMPRESS. STRENGTH (TONS/FT.)			ELEVATION (FT.)			
			SAMPLE NUMBER	RECOV.		MOISTURE				PLASTIC LIMIT %	WATER CONTENT %	LIQUID LIMIT %				
				LENGTH (IN.)	RQD (%)											
1	21	3	S-1	12		M	SM	3" Topsoil-like material								
2		9						Bwn c-f SAND, some c-f Gravel, little Silt (FILL)								
3	23	10	S-2	12		M	GP-GM	Bwn c-f GRAVEL, and c-f Sand, trace Silt								
4		9														
5	17	14	S-3	12		W	SP-SM	Bwn c-f SAND, and c-f Gravel, trace Silt								309.0
6		13														
7	4	7	S-4	10		W	SP-SM	Same								
8		7														
9	9	4	S-5	18		W	SP-SM	Same								
10		2													304.0	
11		3						End of Boring at 10'								
12		6														
13		3														
14																
15																299.0
16																
17																
18																
19																
20																294.0
21																
22																
23																
24																
25																289.0

REMARKS: Elevations are estimated based on topographic survey prepared by Tectonic, entitled "Boundary & Topographic Survey, Lagrange Middle School, 110 Stringham Road, Town of Lagrange, County of Dutchess, State of New York", dated

CLIENT: Arlington Central School District			GROUND WATER	DATE	TIME	DEPTH	INSPECTOR: Ryan Villa	
CONTRACTOR: Core Down Drilling LLC							DRILLER: Kevin Nash	
METHOD OF ADVANCING BORING	DIA.	DEPTH					SURFACE ELEVATION: 313.0	
POWER AUGER:	3 1/4"	0 TO 8'		MON. WELL ☐ YES ☒ NO			DATUM: See Remarks	
ROT. DRILL:		TO	SCREEN DEPTH: --- TO ---			DATE START: 5/14/25		
CASING:		TO	WEATHER: Rain TEMP: 55° F			DATE FINISH: 5/14/25		
DIAMOND CORE:		TO	DEPTH TO ROCK: Not Encountered'			UNCONFINED COMPRESS. STRENGTH ● (TONS/FT)		
Geoprobe 6712DT with Automatic Hammer			*CHANGES IN STRATA ARE INFERRED		1 2 3 4 5		FT.)	

DEPTH (FT.)	N OR MIN./FT.	PENETRATION RESISTANCE (BL/6 IN.)	SAMPLES				UNIFIED SOIL CLASS.	DESCRIPTION OF MATERIAL	LITHOLOGY*	STANDARD PENETRATION (BLOWS/FT.)			ELEVATION (
			SAMPLE NUMBER	RECOV.		MOISTURE				PLASTIC LIMIT %	WATER CONTENT %	LIQUID LIMIT %	
				LENGTH (IN.)	RQD (%)								
1	11	13	S-1	18		M	SM	6" Topsoil-like material					
2		13						Bwn c-f SAND, some Silt, trace f Gravel (FILL)					
3	35	15	S-2	16		M	GP-GM	Bwn c-f GRAVEL, and c-f Sand, trace Silt					
4		14											
5	39	18	S-3	12		M	SP-SM	Bwn c-f SAND, some c-f Gravel, trace Silt					
6		14											
7	12	10	S-4	14		W	SP-SM	Bwn c-f SAND, and c-f Gravel, trace Silt					
8		6											
9	14	6	S-5	12		W	GP-GM	Bwn c-f GRAVEL, and c-f Sand, trace Silt					
10		7											
11		7						End of Boring at 10'					
12		7											
13		8											
14													
15													
16													
17													
18													
19													
20													
21													
22													
23													
24													
25													

REMARKS: Elevations are estimated based on topographic survey prepared by Tectonic, entitled "Boundary & Topographic Survey, Lagrange Middle School, 110 Stringham Road, Town of Lagrange, County of Dutchess, State of New York", dated

CLIENT: Arlington Central School District			GROUND WATER	DATE	TIME	DEPTH	INSPECTOR: Ryan Villa	
CONTRACTOR: Core Down Drilling LLC							DRILLER: Kevin Nash	
METHOD OF ADVANCING BORING	DIA.	DEPTH					SURFACE ELEVATION: 313.0	
POWER AUGER:	3 1/4"	0 TO 15.5'		MON. WELL ☐ YES ☒ NO			DATUM: See Remarks	
ROT. DRILL:		TO	SCREEN DEPTH: --- TO ---			DATE START: 5/15/25		
CASING:		TO	WEATHER: Overcast TEMP: 60° F			DATE FINISH: 5/15/25		
DIAMOND CORE:		TO	DEPTH TO ROCK: 15.5'			UNCONFINED COMPRESS. STRENGTH (TONS/FT)		
Geoprobe 6712DT with Automatic Hammer			*CHANGES IN STRATA ARE INFERRED			1 2 3 4 5		
						FT.)		

DEPTH (FT.)	N OR MIN./FT.	PENETRATION RESISTANCE (BL/6 IN.)	SAMPLES				UNIFIED SOIL CLASS.	DESCRIPTION OF MATERIAL	LITHOLOGY*	PLASTIC LIMIT %			WATER CONTENT %			LIQUID LIMIT %			ELEVATION (FT.)			
			SAMPLE NUMBER	RECOV.		MOISTURE				X	-	-	-	-	-	-	-	-		-	-	-
				LENGTH (IN.)	RQD (%)																	
1								3" Topsoil-like material														
2								Augered to 10'														
3								No SPT sampling performed														
4																						
5																			308.0			
6																						
7																						
8																						
9																						
10																			303.0			
11	11	8 5 6 7	S-1	10		W	GP-GM	Bwn c-f GRAVEL, and c-f Sand, trace Silt														
12																						
13																						
14																						
15	50+	39 50/2	S-2	8		W	SP-SM	Gy-bwn c-f SAND, and c-f Gravel, trace Silt											298.0			
16								Auger refusal @ 15.5' on apparent bedrock (weathered Shale in tip of spoon)														
17																						
18								End of Boring at 15.5'														
19																						
20																			293.0			
21																						
22																						
23																						
24																						
25																			288.0			

REMARKS: Elevations are estimated based on topographic survey prepared by Tectonic, entitled "Boundary & Topographic Survey, Lagrange Middle School, 110 Stringham Road, Town of Lagrange, County of Dutchess, State of New York", dated

CLIENT: Arlington Central School District			GROUND WATER	DATE	TIME	DEPTH	INSPECTOR: Ryan Villa	
CONTRACTOR: Core Down Drilling LLC							DRILLER: Kevin Nash	
METHOD OF ADVANCING BORING	DIA.	DEPTH					SURFACE ELEVATION: 314.0	
POWER AUGER:	3 1/4"	0 TO 11'		MON. WELL ☐ YES ☒ NO			DATUM: See Remarks	
ROT. DRILL:	2 7/8"	0 TO 11'	SCREEN DEPTH: --- TO ---			DATE START: 5/15/25		
CASING:		TO	WEATHER: Overcast TEMP: 60° F			DATE FINISH: 5/15/25		
DIAMOND CORE:	2"	11 TO 16'	DEPTH TO ROCK: 11'			UNCONFINED COMPRESS. STRENGTH (TONS/FT)		
Geoprobe 6712DT with Automatic Hammer			*CHANGES IN STRATA ARE INFERRED			1 2 3 4 5		
						FT.)		

DEPTH (FT.)	N OR MIN./FT.	PENETRATION RESISTANCE (BL/6 IN.)	SAMPLES				UNIFIED SOIL CLASS.	DESCRIPTION OF MATERIAL	LITHOLOGY*	PLASTIC LIMIT %			WATER CONTENT %			LIQUID LIMIT %			ELEVATION (FT.)
			SAMPLE NUMBER	RECOV.		MOISTURE				X	⊗	Δ							
				LENGTH (IN.)	RQD (%)								10	20	30	40	50		
STANDARD PENETRATION (BLOWS/FT.) </																			

REMARKS: Elevations are estimated based on topographic survey prepared by Tectonic, entitled "Boundary & Topographic Survey, Lagrange Middle School, 110 Stringham Road, Town of Lagrange, County of Dutchess, State of New York", dated

BORING LOG 13018.02 MIDDLE SCHOOL.GPJ TECTONIC.ENG.GDT 8/21/25

Tectonic PROJECT No. 13018.02 PROJECT: Arlington CSD - Lagrange Middle School LOCATION: LaGrangeville, NY										BORING No. B-19										SHEET No. 1 of 1																											
										CLIENT: Arlington Central School District										GROUND WATER	DATE		TIME		DEPTH		INSPECTOR: Ryan Villa																				
CONTRACTOR: Core Down Drilling LLC																DRILLER: Kevin Nash																															
METHOD OF ADVANCING BORING					DIA.		DEPTH							SURFACE ELEVATION: 313.5																																	
POWER AUGER:					3 1/4"		0 TO 7'			MON. WELL ☐ YES ☒ NO					DATUM: See Remarks																																
ROT. DRILL:							TO			SCREEN DEPTH: --- TO ---					DATE START: 5/15/25																																
CASING:							TO			WEATHER: Overcast TEMP: 60° F					DATE FINISH: 5/15/25																																
DIAMOND CORE:							TO			DEPTH TO ROCK: 7.1'					UNCONFINED COMPRESS. STRENGTH (TONS/FT) ● 1 2 3 4 5 PLASTIC LIMIT % WATER CONTENT % LIQUID LIMIT % X --- ⊗ --- Δ 10 20 30 40 50 STANDARD PENETRATION (BLOWS/FT.) ● 10 20 30 40 50																																
Geoprobe 6712DT with Automatic Hammer										*CHANGES IN STRATA ARE INFERRED																																					
DEPTH (FT.)		N OR MIN./FT.		PENETRATION RESISTANCE (BL/6 IN.)		SAMPLE NUMBER		RECOV. LENGTH (IN.)		RQD (%)		MOISTURE		UNIFIED SOIL CLASS.		DESCRIPTION OF MATERIAL										LITHOLOGY*		ELEVATION (FT.)																			
1		13		2 5 8 8		S-1		8				M		GM		3" Topsoil-like material Bwn c-f GRAVEL, and c-f Sand, little Silt (FILL)																															
2				8												Bwn c-f GRAVEL, and c-f Sand, trace Silt																															
3		13		5 8 9		S-2		12				M		GP-GM																																	
4																																															
5		50+		23 50/3		S-3		9				M		SP-SM		Bwn c-f SAND, and c-f Gravel, trace Silt												308.5																			
6																Auger refusal at 7.1' on apparent obstruction																															
7																																															
8		50+		50/1		S-4		1				M		SP-SM																																	
9																End of Boring at 7.1'																															
10																																						303.5									
11																																															
12																																															
13																																															
14																																															
15																																						298.5									
16																																															
17																																															
18																																															
19																																															
20																																						293.5									
21																																															
22																																															
23																																															
24																																															
25																																						288.5									
REMARKS: Elevations are estimated based on topographic survey prepared by Tectonic, entitled "Boundary & Topographic Survey, Lagrange Middle School, 110 Stringham Road, Town of Lagrange, County of Dutchess, State of New York", dated																																															

BORING LOG 13018.02 MIDDLE SCHOOL.GPJ TECTONIC.ENG.GDT 8/21/25

Tectonic PROJECT No. 13018.02 PROJECT: Arlington CSD - Lagrange Middle School LOCATION: LaGrangeville, NY										BORING No. B-20									
										SHEET No. 1 of 1									
										CLIENT: Arlington Central School District					GROUND WATER	DATE	TIME	DEPTH	INSPECTOR: Ryan Villa
CONTRACTOR: Core Down Drilling LLC								DRILLER: Kevin Nash											
METHOD OF ADVANCING BORING		DIA.	DEPTH					SURFACE ELEVATION: 314.5											
POWER AUGER:		3 1/4"	0	TO 20'	MON. WELL ☐ YES ☒ NO		DATUM: See Remarks												
ROT. DRILL:				TO	SCREEN DEPTH: --- TO ---		DATE START: 5/15/25												
CASING:				TO	WEATHER: Overcast TEMP: 60° F		DATE FINISH: 5/15/25												
DIAMOND CORE:				TO	DEPTH TO ROCK: Not Encountered'		UNCONFINED COMPRESS. STRENGTH (TONS/FT) ● PLASTIC LIMIT % X --- WATER CONTENT % --- O --- LIQUID LIMIT % --- Δ --- STANDARD PENETRATION (BLOWS/FT.) ● 1 2 3 4 5 10 20 30 40 50												
Geoprobe 6712DT with Automatic Hammer					*CHANGES IN STRATA ARE INFERRED														
DEPTH (FT.)	N OR MIN./FT.	PENETRATION RESISTANCE (BLU/6 IN.)	SAMPLE NUMBER	RECOV. LENGTH (IN.)	RQD (%)	MOISTURE	UNIFIED SOIL CLASS.	DESCRIPTION OF MATERIAL	LITHOLOGY*	ELEVATION (FT.)									
1	11	3 5 6 7	S-1	12		M	SM	3" Topsoil-like material Bwn c-f SAND, some c-f Gravel, little Silt (FILL)											
2																			
3	14	7 6 8 8	S-2	14		M	SM	Bwn c-f SAND, and c-f Gravel, little Silt											
4																			
5	27	12 10 17 13	S-3	2		M	SM	Bwn c-f SAND, little c-f Gravel, little Silt		309.5									
6																			
7	11	0 5 6 7	S-4	14		W	SP-SM	Bwn c-f SAND, some c-f Gravel, trace Silt											
8																			
9	42	9 13 29 16	S-5	18		W	GP-GM	Bwn c-f GRAVEL, and c-f Sand, trace Silt		304.5									
10																			
11	22	13 11 11 18	S-6	12		W	GP-GM	Same											
12																			
13																			
14																			
15										299.5									
16	8	7 4 4 5	S-7	8		W	GP-GM	Same											
17																			
18																			
19																			
20										294.5									
21	10	5 5 5 5	S-8	12		W	SP-SM	Bwn c-f SAND, some c-f Gravel, trace Silt											
22																			
23								End of Boring at 22'											
24																			
25										289.5									
REMARKS: Elevations are estimated based on topographic survey prepared by Tectonic, entitled "Boundary & Topographic Survey, Lagrange Middle School, 110 Stringham Road, Town of Lagrange, County of Dutchess, State of New York", dated																			

CLIENT: Arlington Central School District			GROUND WATER	DATE	TIME	DEPTH	INSPECTOR: Ryan Villa	
CONTRACTOR: Core Down Drilling LLC				5/15/25	2:00 pm	6'	DRILLER: Kevin Nash	
METHOD OF ADVANCING BORING	DIA.	DEPTH					SURFACE ELEVATION: 314.0	
POWER AUGER:	3 1/4"	0 TO 16'		MON. WELL ☐ YES ☒ NO			DATUM: See Remarks	
ROT. DRILL:		TO	SCREEN DEPTH: --- TO ---			DATE START: 5/15/25		
CASING:		TO	WEATHER: Overcast TEMP: 60° F			DATE FINISH: 5/15/25		
DIAMOND CORE:		TO	DEPTH TO ROCK: 16'			UNCONFINED COMPRESS. STRENGTH ● (TONS/FT)		FT.)
Geoprobe 6712DT with Automatic Hammer			*CHANGES IN STRATA ARE INFERRED			1 2 3 4 5		

DEPTH (FT.)	N OR MIN./FT.	PENETRATION RESISTANCE (BLU/IN.)	SAMPLES			UNIFIED SOIL CLASS.	DESCRIPTION OF MATERIAL	LITHOLOGY*	ELEVATION (FT.)
			SAMPLE NUMBER	RECOV. LENGTH (IN.)	RQD (%)				
1	14	2 6 8	S-1	14		M	SM	3" Topsoil-like material	
2		7						Bwn c-f Sand, some c-f Gravel, some Silt (FILL)	
3	15	9 7 8	S-2	12		M	SM	Bwn c-f SAND, and c-f Gravel, little Silt	
4		7							
5	24	8 12 12	S-3	12		M	SM	Same	309.0
6		12							
7	14	9 8 6	S-4	16		W	GP-GM	Bwn c-f GRAVEL, and c-f Sand, trace Silt	
8		7							
9	16	9 11 5	S-5	18		W	SM	Bwn-blk c-f SAND, some c-f Gravel, little Silt	
10		3							304.0
11	13	5 7 6	S-6	18		W	SP-SM	Bwn c-f SAND, little c-f Gravel, trace Silt	
12		6							
13									
14									
15									299.0
16	50+	50/3	S-7	3		W	GP-GM	Bwn-gy c-f GRAVEL, and c-f Sand, trace Silt Auger refusal @ 16' on apparent bedrock (weathered shale in tip of spoon)	
17									
18								End of Boring at 16'	
19									
20									294.0
21									
22									
23									
24									
25									289.0

REMARKS: Elevations are estimated based on topographic survey prepared by Tectonic, entitled "Boundary & Topographic Survey, Lagrange Middle School, 110 Stringham Road, Town of Lagrange, County of Dutchess, State of New York", dated



PROJECT No. **13018.02**
PROJECT: **Arlington CSD - Lagrange Middle School**
LOCATION: **LaGrangeville, NY**

BORING No. B-22

SHEET No. 1 of 1

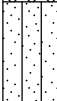
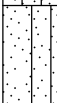
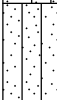
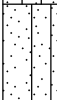
CLIENT: Arlington Central School District			GROUND WATER	DATE	TIME	DEPTH	INSPECTOR: Ryan Villa				
CONTRACTOR: Core Down Drilling LLC							DRILLER: Kevin Nash				
METHOD OF ADVANCING BORING	DIA.	DEPTH					SURFACE ELEVATION: 314.0				
POWER AUGER:	3 1/4"	0 TO 20'		MON. WELL	☐ YES ☒ NO		DATUM: See Remarks				
ROT. DRILL:		TO	SCREEN DEPTH: --- TO ---			DATE START: 5/16/25					
CASING:		TO	WEATHER: Overcast TEMP: 60° F			DATE FINISH: 5/16/25					
DIAMOND CORE:		TO	DEPTH TO ROCK: Not Encountered'			UNCONFINED COMPRESS. STRENGTH ● (TONS/FT)					
Geoprobe 6712DT with Automatic Hammer			*CHANGES IN STRATA ARE INFERRED			1	2	3	4	5	FT.)

DEPTH (FT.)	N OR MIN./FT.	PENETRATION RESISTANCE (BL/6 IN.)	SAMPLES				UNIFIED SOIL CLASS.	DESCRIPTION OF MATERIAL	LITHOLOGY*	PLASTIC LIMIT %			WATER CONTENT %			LIQUID LIMIT %			ELEVATION (FT.)			
			SAMPLE NUMBER	RECOV.		MOISTURE				X	-	-	-	-	-	-	-	-		-	-	
				LENGTH (IN.)	RQD (%)																	10
											STANDARD PENETRATION (BLOWS/FT.)											
1	11	5	S-1	20		M	SM	1" Topsoil-like material Bwn c-f Sand, and c-f Gravel, some Silt (FILL)														
2		6																				
3	7	4	S-2	6		M	SM	Same (FILL)														
4		3																				
5	9	2	S-3	14		M	SM	Bwn c-f SAND, and c-f Gravel, little Silt											309.0			
6		3																				
7	10	4	S-4	10		W	SP-SM	Bwn c-f SAND, and c-f Gravel, trace Silt														
8		4																				
9	7	7	S-5	12		W	SP-SM	Same														
10		4																				
11	11	6	S-6	8		W	GP-GM	Bwn c-f GRAVEL, and c-f Sand, trace Silt (FILL)														
12		5																				
13		8																				
14																						
15																			299.0			
16	10	4	S-7	12		W	GP-GM	Same (FILL)														
17		4																				
18		6																				
19		10																				
20																			294.0			
21	13	6	S-8	12		W	GP-GM	Same (FILL)														
22		6																				
23		7																				
24		7																				
25								End of Boring at 22'											289.0			

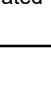
REMARKS: Elevations are estimated based on topographic survey prepared by Tectonic, entitled "Boundary & Topographic Survey, Lagrange Middle School, 110 Stringham Road, Town of Lagrange, County of Dutchess, State of New York", dated

BORING LOG 13018.02 MIDDLE SCHOOL.GPJ TECTONIC.ENG.GDT 8/21/25

Tectonic PROJECT No. 13018.02 PROJECT: Arlington CSD - Lagrange Middle School LOCATION: LaGrangeville, NY										BORING No. B-23									
										SHEET No. 1 of 1									
										CLIENT: Arlington Central School District					GROUND WATER	DATE	TIME	DEPTH	INSPECTOR: Ryan Villa
CONTRACTOR: Core Down Drilling LLC								DRILLER: Kevin Nash											
METHOD OF ADVANCING BORING		DIA.	DEPTH					SURFACE ELEVATION: 314.0											
POWER AUGER:		3 1/4"	0	TO 20'	MON. WELL ☐ YES ☒ NO		DATUM: See Remarks												
ROT. DRILL:				TO	SCREEN DEPTH: --- TO ---		DATE START: 5/16/25												
CASING:				TO	WEATHER: Overcast TEMP: 60° F		DATE FINISH: 5/16/25												
DIAMOND CORE:				TO	DEPTH TO ROCK: Not Encountered'		UNCONFINED COMPRESS. STRENGTH (TONS/FT) ● PLASTIC LIMIT % X 10 20 30 40 50 WATER CONTENT % ⊗ 10 20 30 40 50 LIQUID LIMIT % Δ 10 20 30 40 50 STANDARD PENETRATION (BLOWS/FT.) ● 10 20 30 40 50												
Geoprobe 6712DT with Automatic Hammer					*CHANGES IN STRATA ARE INFERRED														
DEPTH (FT.)	N OR MIN./FT.	PENETRATION RESISTANCE (BLU/6 IN.)	SAMPLES		UNIFIED SOIL CLASS.	DESCRIPTION OF MATERIAL	LITHOLOGY*			ELEVATION (FT.)									
			SAMPLE NUMBER	RECOV. LENGTH (IN.) RQD (%) MOISTURE															
1	10	1 4 6	S-1	12		M	SM	1" Topsoil-like material											
2		20						Bwn c-f SAND, some Silt, trace f Gravel (FILL)											
3	10	10 6 4	S-2	0		M		No Recovery											
4		4																	
5	12	4 5 7	S-3	12		M	SM	Bwn c-f SAND, little c-f Gravel, little Silt		309.0									
6		9																	
7	13	10 7 6	S-4	12		W	SP-SM	Bwn c-f SAND, and c-f Gravel, trace Silt											
8		5																	
9	10	5 5 5	S-5	12		W	SP-SM	Same											
10		6								304.0									
11	12	7 7 5	S-6	12		W	SP-SM	Same											
12		4																	
13																			
14																			
15										299.0									
16	10	5 4 6	S-7	16		W	SP-SM	Same											
17		9																	
18																			
19																			
20										294.0									
21	17	7 8 9	S-8	16		W	SM	Bwn c-f SAND, little Silt, trace c-f Gravel											
22		9																	
23								End of Boring at 22'											
24																			
25										289.0									
REMARKS: Elevations are estimated based on topographic survey prepared by Tectonic, entitled "Boundary & Topographic Survey, Lagrange Middle School, 110 Stringham Road, Town of Lagrange, County of Dutchess, State of New York", dated																			

CLIENT: Arlington Central School District				GROUND WATER	DATE	TIME	DEPTH	INSPECTOR: Ryan Villa			
CONTRACTOR: Core Down Drilling LLC					5/16/24	12:00 pm	6.2'	DRILLER: Kevin Nash			
METHOD OF ADVANCING BORING		DIA.	DEPTH					SURFACE ELEVATION: 314.0			
POWER AUGER:		3 1/4"	0	TO	20'	MON. WELL ☐ YES ☒ NO		DATUM: See Remarks			
ROT. DRILL:				TO		SCREEN DEPTH: --- TO ---		DATE START: 5/16/25			
CASING:				TO		WEATHER: Overcast TEMP: 60° F		DATE FINISH: 5/16/25			
DIAMOND CORE:				TO		DEPTH TO ROCK: Not Encountered'		UNCONFINED COMPRESS. STRENGTH (TONS/FT) ●		ELEVATION (FT.)	
Geoprobe 6712DT with Automatic Hammer				*CHANGES IN STRATA ARE INFERRED				1 2 3 4 5			
DEPTH (FT.)	N OR MIN./FT.	PENETRATION RESISTANCE (BL/6 IN.)	SAMPLES			UNIFIED SOIL CLASS.	DESCRIPTION OF MATERIAL	LITHOLOGY*	PLASTIC LIMIT % WATER CONTENT % LIQUID LIMIT % X-----○-----△ 10 20 30 40 50		
			SAMPLE NUMBER	RECOV.					MOISTURE	STANDARD PENETRATION (BLOWS/FT.) ● 10 20 30 40 50	
LENGTH (IN.)	RQD (%)										
1	7	2 4 3	S-1	12		M	SM	3" Topsoil-like material Bwn c-f SAND, and Silt, little c-f Gravel (FILL)		●	
2		5									
3	20	7 10 10	S-2	12		M	SM	Bwn c-f SAND, and c-f Gravel, little Silt		●	
4		9									
5	17	9 8	S-3	12		M	SM	Bwn c-f SAND, little c-f Gravel, little Silt		●	309.0
6		8									
7	17	8 7 10	S-4	10		W	SP-SM	Bwn c-f SAND, and c-f Gravel, trace Silt		●	
8		11									
9	16	8 9 7	S-5	12		W	SM	Bwn c-f SAND, and c-f Gravel, little Silt		●	304.0
10		11									
11	24	17 12 12	S-6	6		W	SP-SM	Bwn c-f SAND, some c-f Gravel, trace Silt		●	
12		11									
13											
14											
15											
16	8	6 4 4	S-7	10		W	SP-SM	Bwn c-f SAND, and c-f Gravel, trace Silt		●	299.0
17		5									
18											
19											
20											
21	11	6 6 5	S-8	12		W	SP-SM	Bwn c-f SAND, some c-f Gravel, trace Silt		●	294.0
22		6									
23								End of Boring at 22'			
24											
25											289.0

CLIENT: Arlington Central School District			GROUND WATER	DATE	TIME	DEPTH	INSPECTOR: Ryan Villa	
CONTRACTOR: Core Down Drilling LLC				5/16/24	1:15 pm	7.5'	DRILLER: Kevin Nash	
METHOD OF ADVANCING BORING	DIA.	DEPTH					SURFACE ELEVATION: 313.5	
POWER AUGER:	3 1/4"	0 TO 20'		MON. WELL ☐ YES ☒ NO			DATUM: See Remarks	
ROT. DRILL:		TO	SCREEN DEPTH: --- TO ---			DATE START: 5/16/25		
CASING:		TO	WEATHER: Overcast TEMP: 60° F			DATE FINISH: 5/16/25		
DIAMOND CORE:		TO	DEPTH TO ROCK: Not Encountered'			UNCONFINED COMPRESS. STRENGTH ● (TONS/FT)		
Geoprobe 6712DT with Automatic Hammer			*CHANGES IN STRATA ARE INFERRED			1 2 3 4 5		
						FT.)		

DEPTH (FT.)	N OR MIN./FT.	PENETRATION RESISTANCE (BL/6 IN.)	SAMPLES				UNIFIED SOIL CLASS.	DESCRIPTION OF MATERIAL	LITHOLOGY*	PLASTIC LIMIT %	WATER CONTENT %	LIQUID LIMIT %	ELEVATION (FT.)					
			SAMPLE NUMBER	RECOV.		MOISTURE				—X—	—⊗—	—△—						
				LENGTH (IN.)	RQD (%)					10	20	30		40	50			
STANDARD PENETRATION (BLOWS/FT.)																		
1	10	1	S-1	8		M	SM	1" Topsoil-like material Bwn c-f SAND, and Silt, trace f Gravel (FILL)		●								
2		2																
3	6	4								S-2	2		M	SM	Bwn c-f SAND, some c-f Gravel, some Silt, trace plastic (FILL)		●	
4		2																
5	3	1	S-3	12		M	SM	Bwn c-f SAND, some Silt, little c-f Gravel (FILL)									●	
6		2																
7	13	4								S-4	12		W	GM	Bwn c-f Gravel, and c-f Sand, little Silt		●	
8		5																
9	13	6	S-5	12		W	GM	Same									●	
10		7																
11	12	6								S-6	14		W	SP-SM	Bwn c-f SAND, and c-f Gravel, trace Silt		●	
12		5																
13		7																
14		9																
15													298.5					
16	5	3	S-7	12		W	GP-GM	Bwn c-f GRAVEL, and c-f Sand, trace Silt		●								
17		3																
18		2																
19		3																
20													293.5					
21	10	6	S-8	12		W	SP-SM	Bwn c-f SAND, and c-f Gravel, trace Silt		●								
22		5																
23		5																
24		4																
25								End of Boring at 22'					288.5					

REMARKS: Elevations are estimated based on topographic survey prepared by Tectonic, entitled "Boundary & Topographic Survey, Lagrange Middle School, 110 Stringham Road, Town of Lagrange, County of Dutchess, State of New York", dated

CLIENT: Arlington Central School District			GROUND WATER	DATE	TIME	DEPTH	INSPECTOR: Ryan Villa	
CONTRACTOR: Core Down Drilling LLC							DRILLER: Kevin Nash	
METHOD OF ADVANCING BORING	DIA.	DEPTH					SURFACE ELEVATION: 314.0	
POWER AUGER:	3 1/4"	0 TO 39.5'		MON. WELL ☐ YES ☒ NO			DATUM: See Remarks	
ROT. DRILL:	2 7/8"	0 TO 39.5'	SCREEN DEPTH: --- TO ---			DATE START: 5/19/25		
CASING:		TO	WEATHER: Clear TEMP: 60° F			DATE FINISH: 5/19/25		
DIAMOND CORE:	2"	39.5 TO 44.5'	DEPTH TO ROCK: 39.5'			UNCONFINED COMPRESS. STRENGTH ● (TONS/FT)		FT.)
Geoprobe 6712DT with Automatic Hammer			*CHANGES IN STRATA ARE INFERRED			1 2 3 4 5		

DEPTH (FT.)	N OR MIN./FT.	PENETRATION RESISTANCE (BL/6 IN.)	SAMPLES				UNIFIED SOIL CLASS.	DESCRIPTION OF MATERIAL	LITHOLOGY*	PLASTIC LIMIT %			WATER CONTENT %			LIQUID LIMIT %			ELEVATION (FT.)
			SAMPLE NUMBER	RECOV.		MOISTURE				X	⊗	Δ							
				LENGTH (IN.)	RQD (%)											10	20	30	
											STANDARD PENETRATION (BLOWS/FT.)								
1	11	265	S-1	19		M	SM	3" Topsoil-like material Bwn c-f SAND, some c-f Gravel, some Silt (FILL)											
2		11																	
3	24	131410	S-2	12		M	SM	Bwn c-f SAND, and c-f Gravel, little Silt											
4		11																	
5	12	7755	S-3	16		M	GW-GM	Bwn c-f GRAVEL, and c-f Sand, trace Silt									309.0		
6		4																	
7	8	444	S-4	12		W	SP-SM	Bwn c-f SAND, some c-f Gravel, trace Silt											
8		3																	
9	8	5355	S-5	12		W	SP-SM	Bwn c-f SAND, little c-f Gravel, trace Silt											
10		5															304.0		
11	13	6776	S-6	16		W	SP-SM	Same											
12		5																	
13																			
14																			
15																	299.0		
16	15	6699	S-7	16		W	SP-SM	Bwn c-f SAND, little f Gravel, trace Silt											
17		9																	
18																			
19																			
20																	294.0		
21	10	7555	S-8	16		W	SM	Bwn c-f SAND, little f Gravel, little Silt											
22		7																	
23																			
24																			
25																		289.0	

REMARKS: Elevations are estimated based on topographic survey prepared by Tectonic, entitled "Boundary & Topographic Survey, Lagrange Middle School, 110 Stringham Road, Town of Lagrange, County of Dutchess, State of New York", dated

CLIENT: Arlington Central School District

CONTRACTOR: Core Down Drilling LLC

DEPTH (FT.)	N OR MIN./FT.	PENETRATION RESISTANCE (BL/6 IN.)	SAMPLES				UNIFIED SOIL CLASS.	DESCRIPTION OF MATERIAL	LITHOLOGY*	UNCONFINED COMPRESS. STRENGTH (TONS/FT.)			ELEVATION (FT.)			
			SAMPLE NUMBER	RECOV.		MOISTURE				PLASTIC LIMIT %	WATER CONTENT %	LIQUID LIMIT %				
				LENGTH (IN.)	RQD (%)											
26	10	8	S-9	16		W	SP-SM	Bwn c-f SAND, trace c-f Gravel, trace Silt								
27		5														
28		5														
29		6														
30																284.0
31	9	3	S-10	18		W	SM	Bwn f SAND, little Silt								
32		4														
33		5														
34		7														
35																279.0
36	16	5	S-11	18		W	SM	9" Bwn c-f SAND, little Silt 9" Gy f SAND, and Silt, little c Gravel								
37		7														
38		9														
39		9														
40	4.0							Auger refusal @ 39.5'								274.0
41	4.5															
42	5.0		C-1	50/60	27			Gy, slightly to moderately weathered, moderately to highly fractured, f grained, hard SHALE, fractures 0 - 90 degrees from horizontal								
43	3.0															
44	4.0															
45								End of Boring at 44.5'								269.0
46																
47																
48																
49																
50																264.0
51																
52																
53																
54																
55																259.0

REMARKS: Elevations are estimated based on topographic survey prepared by Tectonic, entitled "Boundary & Topographic Survey, Lagrange Middle School, 110 Stringham Road, Town of Lagrange, County of Dutchess, State of New York", dated

BORING LOG 13018.02 MIDDLE SCHOOL.GPJ TECTONIC.ENG.GDT 8/21/25

Tectonic										PROJECT No. 13018.02				BORING No. P-1						
										PROJECT: Arlington CSD - Lagrange Middle School										
										LOCATION: LaGrangeville, NY								SHEET No. 1 of 1		
CLIENT: Arlington Central School District										GROUND WATER	DATE	TIME	DEPTH	INSPECTOR: Ryan Villa						
CONTRACTOR: Core Down Drilling LLC														DRILLER: Kevin Nash						
METHOD OF ADVANCING BORING				DIA.	DEPTH						SURFACE ELEVATION: 313.5									
POWER AUGER:				3 1/4"	0	TO	5.5'	MON. WELL ☐ YES ☒ NO				DATUM: See Remarks								
ROT. DRILL:						TO		SCREEN DEPTH: --- TO ---				DATE START: 5/15/25								
CASING:						TO		WEATHER: Overcast TEMP: 60° F				DATE FINISH: 5/15/25								
DIAMOND CORE:						TO		DEPTH TO ROCK: 5.5'				UNCONFINED COMPRESS. STRENGTH (TONS/FT) ● 1 2 3 4 5 PLASTIC LIMIT % WATER CONTENT % LIQUID LIMIT % × --- ○ --- △ 10 20 30 40 50 ● STANDARD PENETRATION (BLOWS/FT.) 10 20 30 40 50								
Geoprobe 6712DT with Automatic Hammer								*CHANGES IN STRATA ARE INFERRED												
DEPTH (FT.)	N OR MIN./FT.	PENETRATION RESISTANCE (BLU/6 IN.)	SAMPLES			UNIFIED SOIL CLASS.	DESCRIPTION OF MATERIAL	LITHOLOGY*							ELEVATION (FT.)					
			SAMPLE NUMBER	RECOV.												MOISTURE				
LENGTH (IN.)	RQD (%)																			
1							3" Topsoil-like material													
2							Augered to 5.5' No SPT sampling performed Auger refusal @ 5.5' on apparent bedrock, or cobble or boulder obstruction													
3						M														
4																				
5																				308.5
6							End of Boring at 5.5'													
7																				
8																				
9																				
10																				303.5
11																				
12																				
13																				
14																				
15																				298.5
16																				
17																				
18																				
19																				
20																				293.5
21																				
22																				
23																				
24																				
25																			288.5	
REMARKS: Elevations are estimated based on topographic survey prepared by Tectonic, entitled "Boundary & Topographic Survey, Lagrange Middle School, 110 Stringham Road, Town of Lagrange, County of Dutchess, State of New York", dated																				

BORING LOG 13018.02 MIDDLE SCHOOL.GPJ TECTONIC ENG.GDT 8/21/25

Tectonic										PROJECT No. 13018.02				BORING No. PB-1					
										PROJECT: Arlington CSD - Lagrange Middle School									
										LOCATION: LaGrangeville, NY								SHEET No. 1 of 1	
CLIENT: Arlington Central School District								GROUND WATER	DATE	TIME	DEPTH	INSPECTOR: Ryan Villa							
CONTRACTOR: Core Down Drilling LLC												DRILLER: Kevin Nash							
METHOD OF ADVANCING BORING				DIA.	DEPTH							SURFACE ELEVATION: 314.5							
POWER AUGER:				3 1/4"	0	TO	3'	MON. WELL ☐ YES ☒ NO				DATUM: See Remarks							
ROT. DRILL:						TO		SCREEN DEPTH: --- TO ---				DATE START: 5/15/25							
CASING:						TO		WEATHER: Overcast TEMP: 60° F				DATE FINISH: 5/15/25							
DIAMOND CORE:						TO		DEPTH TO ROCK: Not Encountered'				UNCONFINED COMPRESS. STRENGTH (TONS/FT) ● 1 2 3 4 5 PLASTIC LIMIT % WATER CONTENT % LIQUID LIMIT % × --- ⊗ --- △ 10 20 30 40 50 ● STANDARD PENETRATION (BLOWS/FT.) 10 20 30 40 50							
Geoprobe 6712DT with Automatic Hammer								*CHANGES IN STRATA ARE INFERRED											
DEPTH (FT.)	N OR MIN./FT.	PENETRATION RESISTANCE (BLU/6 IN.)	SAMPLES			UNIFIED SOIL CLASS.	DESCRIPTION OF MATERIAL	LITHOLOGY*							ELEVATION (FT.)				
			SAMPLE NUMBER	RECOV.												MOISTURE			
LENGTH (IN.)	RQD (%)																		
1						M	SM	4" Asphalt pavement and 6" gravel subbase											
2								Bwn c-f SAND, some c-f Gravel, little Silt											
3																			
4								End of Boring at 3'											
5																			309.5
6																			
7																			
8																			
9																			
10																			304.5
11																			
12																			
13																			
14																			
15																			299.5
16																			
17																			
18																			
19																			
20																			294.5
21																			
22																			
23																			
24																			
25																			289.5
REMARKS: Elevations are estimated based on topographic survey prepared by Tectonic, entitled "Boundary & Topographic Survey, Lagrange Middle School, 110 Stringham Road, Town of Lagrange, County of Dutchess, State of New York", dated																			

BORING LOG 13018.02 MIDDLE SCHOOL.GPJ TECTONIC.ENG.GDT 8/21/25

Tectonic										PROJECT No. 13018.02				BORING No. PB-2					
										PROJECT: Arlington CSD - Lagrange Middle School									
										LOCATION: LaGrangeville, NY								SHEET No. 1 of 1	
CLIENT: Arlington Central School District								GROUND WATER	DATE	TIME	DEPTH	INSPECTOR: Ryan Villa							
CONTRACTOR: Core Down Drilling LLC												DRILLER: Kevin Nash							
METHOD OF ADVANCING BORING				DIA.	DEPTH							SURFACE ELEVATION: 313.0							
POWER AUGER:				3 1/4"	0	TO	3'	MON. WELL ☐ YES ☒ NO				DATUM: See Remarks							
ROT. DRILL:						TO	SCREEN DEPTH: --- TO ---				DATE START: 5/15/25								
CASING:						TO	WEATHER: Overcast TEMP: 60° F				DATE FINISH: 5/15/25								
DIAMOND CORE:						TO	DEPTH TO ROCK: Not Encountered'				UNCONFINED COMPRESS. STRENGTH (TONS/FT) ● 1 2 3 4 5 PLASTIC LIMIT % WATER CONTENT % LIQUID LIMIT % × --- ⊗ --- △ 10 20 30 40 50 ● STANDARD PENETRATION (BLOWS/FT.) 10 20 30 40 50								
Geoprobe 6712DT with Automatic Hammer								*CHANGES IN STRATA ARE INFERRED											
DEPTH (FT.)	N OR MIN./FT.	PENETRATION RESISTANCE (BLU/6 IN.)	SAMPLES			UNIFIED SOIL CLASS.	DESCRIPTION OF MATERIAL	LITHOLOGY*							ELEVATION (FT.)				
			SAMPLE NUMBER	RECOV.	MOISTURE														
			LENGTH (IN.)	RQD (%)															
1						M	SM	4" Asphalt pavement and 6" gravel subbase											
2								Bwn c-f SAND, and c-f Gravel, little Silt											
3																			
4								End of Boring at 3'											
5																308.0			
6																			
7																			
8																			
9																			
10																303.0			
11																			
12																			
13																			
14																			
15																298.0			
16																			
17																			
18																			
19																			
20																293.0			
21																			
22																			
23																			
24																			
25																288.0			
REMARKS: Elevations are estimated based on topographic survey prepared by Tectonic, entitled "Boundary & Topographic Survey, Lagrange Middle School, 110 Stringham Road, Town of Lagrange, County of Dutchess, State of New York", dated																			

LEGEND FOR SOIL DESCRIPTION

COARSE GRAINED SOIL		(Coarser than No. 200 Sieve)					
DESCRIPTIVE TERM & GRAIN SIZE							
TERM		SAND			GRAVEL		
coarse	- c	No.	4	Sieve to No.	10	Sieve	3" to 3/4"
medium	- m	No.	10	Sieve to No.	40	Sieve	3/4" to 3/16"
fine	- f	No,	40	Sieve to No.	200	Sieve	
COBBLES		3" to 10"			BOULDERS		10" +
GRADATION DESIGNATIONS				PROPORTIONS OF COMPONENT			
fine, f				Less than 10% coarse to medium			
medium to fine, m-f				Less than 10% coarse			
medium, m				Less than 10% coarse and fine			
coarse to medium, c-m				Less than 10% fine			
coarse, c				Less than 10% medium and fine			
coarse to fine, c-f				All greater than 10%			

FINE GRAINED SOIL		(Finer than No. 200 Sieve)			
DESCRIPTION		PLASTICITY INDEX		PLASTICITY	
Silt		0 - 1		none	
Clayey Silt		2 - 5		slight	
Silt & Clay		6 - 10		low	
Clay & Silt		11 - 20		medium	
Silty Clay		21 - 40		high	
Clay		greater than 40		very high	

PROPORTION			
DESCRIPTIVE TERM		PERCENT OF SAMPLE WEIGHT	
trace		1 - 10	
little		10 - 20	
some		20 - 35	
and		35 - 50	
The primary component is fully capitalized if >50% of sample			

COLOR			
Blue	- blue	Gy - gray	Wh - white
Blk	- black	Or - orange	Yl - yellow
Bwn	- brown	Rd - red	Lgt - light
Gn	- green	Tn - tan	Dk - dark

SAMPLE NOTATION			
S	- Split Spoon Soil Sample	WOC	- Weight of Casing
U	- Undisturbed Tube Sample	WOR	- Weight of Rods
C	- Core Sample	WOH	- Weight of Hammer
B	- Bulk Soil Sample	PPR	- Compressive Strength based on Pocket Penetrometer
NR	- No Recovery of Sample	TV	- Shear Strength (tsf) based on Torvane

ADDITIONAL CLASSIFICATIONS	
New York City Building Code soil classifications are given in parentheses at the end of each description of material, if applicable. See sections 1804.2 of the 2008 Building Code for further details.	



1279 Route 300
Newburgh, NY 12550
(845) 567-6656

INFILTRATION TEST DATA

W.O. No.: 13018.02 Lot No.: _____ Date: 5/14/2025

Client: Arlington Central School District

Project: Arlington Central School District - Lagrange Middle School

Project Engineer: Ryan Villa

Inspector: Ryan Villa

Infiltration Test Location: (see reverse) See Boring Location Plan

Weather Conditions: Overcast Temperature: 60

TEST HOLE No.	TEST HOLE DEPTH	TEST HOLE DIA.		INFILTRATION TEST RUNS						STABLE RATE (in/hr)
				Drop in water levels (inches) at 1-hour intervals						
INF-1	4'	4"	7:58 AM	1	1	1	1			1
			TIME	8:58:00	9:58:00	10:58:00	11:58:00			

COMMENTS: Stable rate recorded as last observed ready

INF-2	4'	4"	7:57 AM	9	10	10	10			10
			TIME	8:57:00	9:57:00	10:57:00	11:57:00			

COMMENTS:

Sketch Requirements

(To Be Completed On Back of Sheet)

Indicate North

Indicate Nearest Roadway

Indicate Property Lines

Indicate Off-Sets from 2 Adjacent Property Lines



1279 Route 300
Newburgh, NY 12550
(845) 567-6656

INFILTRATION TEST DATA

W.O. No.: 13018.02 Lot No.: _____ Date: 5/15/2025

Client: Arlington Central School District

Project: Arlington Central School District - Lagrange Middle School

Project Engineer: Ryan Villa

Inspector: Ryan Villa

Infiltration Test Location: (see reverse) See Boring Location Plan

Weather Conditions: Overcast Temperature: 60

TEST HOLE No.	TEST HOLE DEPTH	TEST HOLE DIA.		INFILTRATION TEST RUNS Drop in water levels (inches) at 1-hour intervals						STABLE RATE (in/hr)
INF-3	4'	4"	7:55 AM	14	13	13	13			13
			TIME	8:55:00	9:55:00	10:55:00	11:55:00			

COMMENTS: Stable rate = last reading

INF-4	4'	4"	8:00 AM	3.5	3.0	1.5	0.5	0.5		1
			TIME	9:00:00	10:00:00	11:00:00	12:00:00	13:00:00		

COMMENTS: Stable rate = last reading

Sketch Requirements

(To Be Completed On Back of Sheet)

Indicate North

Indicate Nearest Roadway

Indicate Property Lines

Indicate Off-Sets from 2 Adjacent Property Lines



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INFILTRATION TEST DATA

W.O. No.: 13018.02 Lot No.: _____ Date: 5/15/2025

Client: Arlington Central School District

Project: Arlington Central School District - Lagrange Middle School

Project Engineer: Ryan Villa

Inspector: Ryan Villa

Infiltration Test Location: (see reverse) See Boring Location Plan

Weather Conditions: Overcast Temperature: 60

TEST HOLE No.	TEST HOLE DEPTH	TEST HOLE DIA.		INFILTRATION TEST RUNS Drop in water levels (inches) at 1-hour intervals						STABLE RATE (in/hr)
INF-5	3'	4"	7:49 AM	5	3	3	3			3
			TIME	8:58:00	9:58:00	10:58:00	11:58:00			
COMMENTS: Stable rate = last reading										
INF-6	3'	4"	7:50 AM	1	0	1	0			0.5
			TIME	8:50:00	9:50:00	10:50:00	11:50:00			
COMMENTS: Stable rate = last reading										
Sketch Requirements										
(To Be Completed On Back of Sheet)										
Indicate North					Indicate Nearest Roadway					
Indicate Property Lines					Indicate Off-Sets from 2 Adjacent Property Lines					



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INFILTRATION TEST DATA

W.O. No.: 13018.02 Lot No.: _____ Date: 5/14/2025

Client: Arlington Central School District

Project: Arlington Central School District - Lagrange Middle School

Project Engineer: Ryan Villa

Inspector: Ryan Villa

Infiltration Test Location: (see reverse) See Boring Location Plan

Weather Conditions: Overcast Temperature: 60

TEST HOLE No.	TEST HOLE DEPTH	TEST HOLE DIA.		INFILTRATION TEST RUNS						STABLE RATE
				Drop in water levels (inches) at 1-hour intervals						(in/hr)
INF-7	3'	4"	7:43 AM	24	16	15	15			15
			TIME	8:43:00	9:43:00	10:43:00	11:43:00			

COMMENTS: Stable rate = last reading

INF-8	3'	4"	7:40 AM	1	1	0	0			0
			TIME	8:40:00	9:40:00	10:40:00	11:40:00			

COMMENTS: Stable rate = last reading

Sketch Requirements

(To Be Completed On Back of Sheet)

Indicate North

Indicate Nearest Roadway

Indicate Property Lines

Indicate Off-Sets from 2 Adjacent Property Lines



1279 Route 300
Newburgh, NY 12550
(845) 567-6656

INFILTRATION TEST DATA

W.O. No.: 13018.02 Lot No.: _____ Date: 5/16/2025

Client: Arlington Central School District

Project: Arlington Central School District - Lagrange Middle School

Project Engineer: Ryan Villa

Inspector: Ryan Villa

Infiltration Test Location: (see reverse) See Boring Location Plan

Weather Conditions: Overcast Temperature: 60

TEST HOLE No.	TEST HOLE DEPTH	TEST HOLE DIA.		INFILTRATION TEST RUNS Drop in water levels (inches) at 1-hour intervals						STABLE RATE (in/hr)
INF-9	4'	4"	7:05 AM	24	20	20	21			21
			TIME	8:05:00	9:05:00	10:05:00	11:05:00			

COMMENTS: Stable rate = last reading

INF-10	4'	4"	7:12 AM	24	24	24	24			48
			TIME	8:12:00	9:12:00	10:12:00	11:12:00			

COMMENTS: Stable rate = last reading
24 inches in 30 min

Sketch Requirements

(To Be Completed On Back of Sheet)

Indicate North

Indicate Nearest Roadway

Indicate Property Lines

Indicate Off-Sets from 2 Adjacent Property Lines



1279 Route 300
Newburgh, NY 12550
(845) 567-6656

INFILTRATION TEST DATA

W.O. No.: 13018.02 Lot No.: _____ Date: 5/16/2025

Client: Arlington Central School District

Project: Arlington Central School District - Lagrange Middle School

Project Engineer: Ryan Villa

Inspector: Ryan Villa

Infiltration Test Location: (see reverse) See Boring Location Plan

Weather Conditions: Overcast Temperature: 60

TEST HOLE No.	TEST HOLE DEPTH	TEST HOLE DIA.		INFILTRATION TEST RUNS Drop in water levels (inches) at 1-hour intervals						STABLE RATE (in/hr)
INF-11	4'	4"	7:15 AM	14	13	14	13			14
			TIME	8:15:00	9:15:00	10:15:00	11:15:00			

COMMENTS: Stable rate = last reading

INF-12	4'	4"	7:18 AM	15	13	14	14			14
			TIME	8:18:00	9:18:00	10:18:00	11:18:00			

COMMENTS: Stable rate = last reading

Sketch Requirements

(To Be Completed On Back of Sheet)

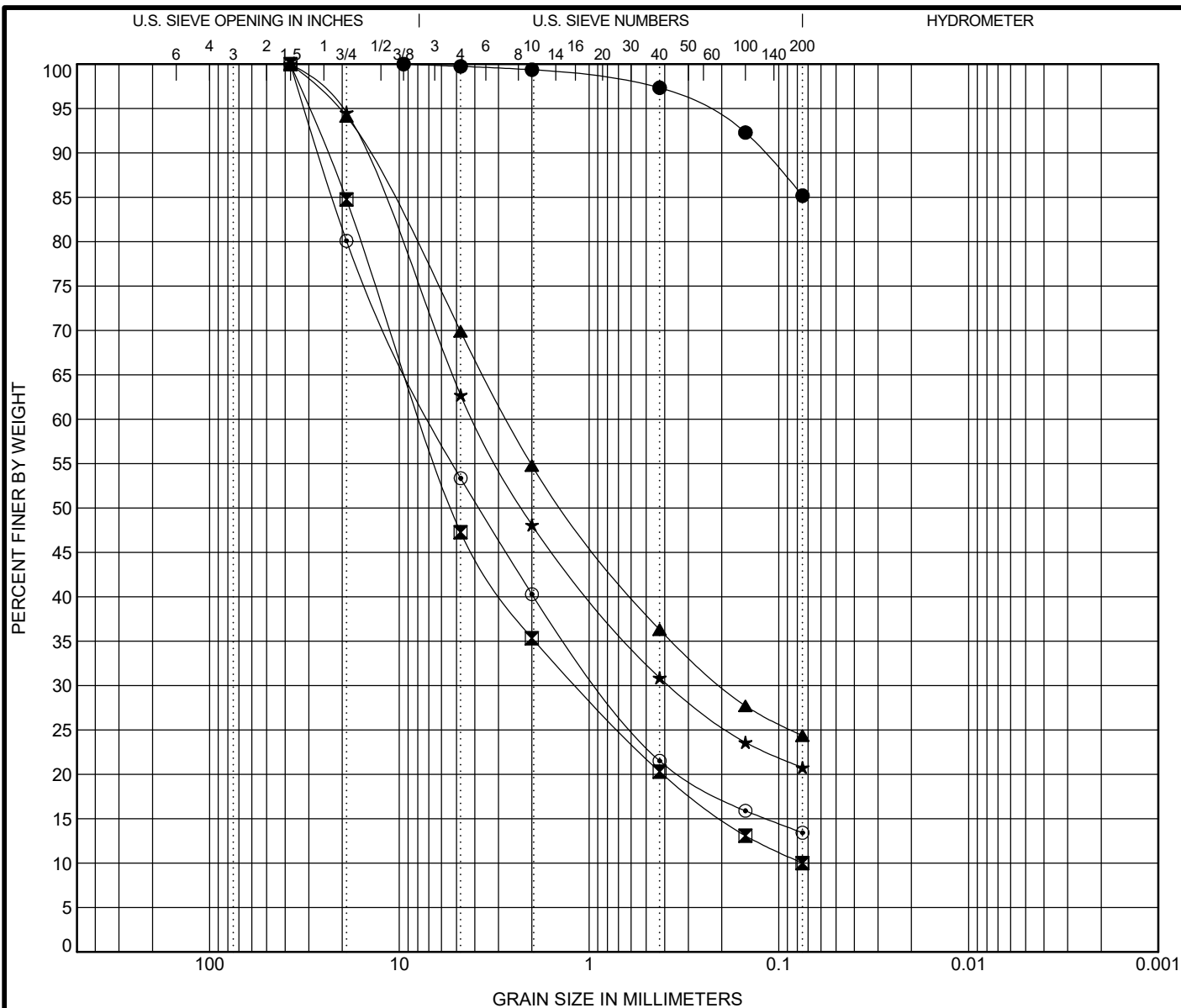
Indicate North

Indicate Nearest Roadway

Indicate Property Lines

Indicate Off-Sets from 2 Adjacent Property Lines

APPENDIX II



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Sample Identification				Classification				WC%	LL	PL	PI	Cc	Cu
●	B-13	0.0	S-1	Bwn SILT, little m-f Sand				30.3					
☒	B-18	4.0	S-3	Bwn c-f GRAVEL, and c-f Sand, trace Silt				7.6				2.33	101.43
▲	B-21	0.0	S-1	Bwn c-f Sand, some c-f Gravel, some Silt				11.0					
★	B-22	2.0	S-2	Bwn c-f Sand, and c-f Gravel, some Silt				10.9					
◎	B-25	6.0	S-4	Bwn c-f Gravel, and c-f Sand, little Silt				9.2					
Sample Identification				D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay	Source of Material	
●	B-13	0.0	S-1	9.5				0.3	14.6	85.2		Boring	
☒	B-18	4.0	S-3	37.5	7.607	1.154	0.075	52.7	37.3	10.0		Boring	
▲	B-21	0.0	S-1	37.5	2.697	0.198		30.1	45.5	24.4		Boring	
★	B-22	2.0	S-2	37.5	4.044	0.375		37.3	42.0	20.8		Boring	
◎	B-25	6.0	S-4	37.5	6.703	0.856		46.6	39.9	13.4		Boring	

Tectonic

280 Little Britain Road, Bldg. 2
Newburgh, NY 12550
Telephone: (845) 563-9081

Fax: (845) 563-9085

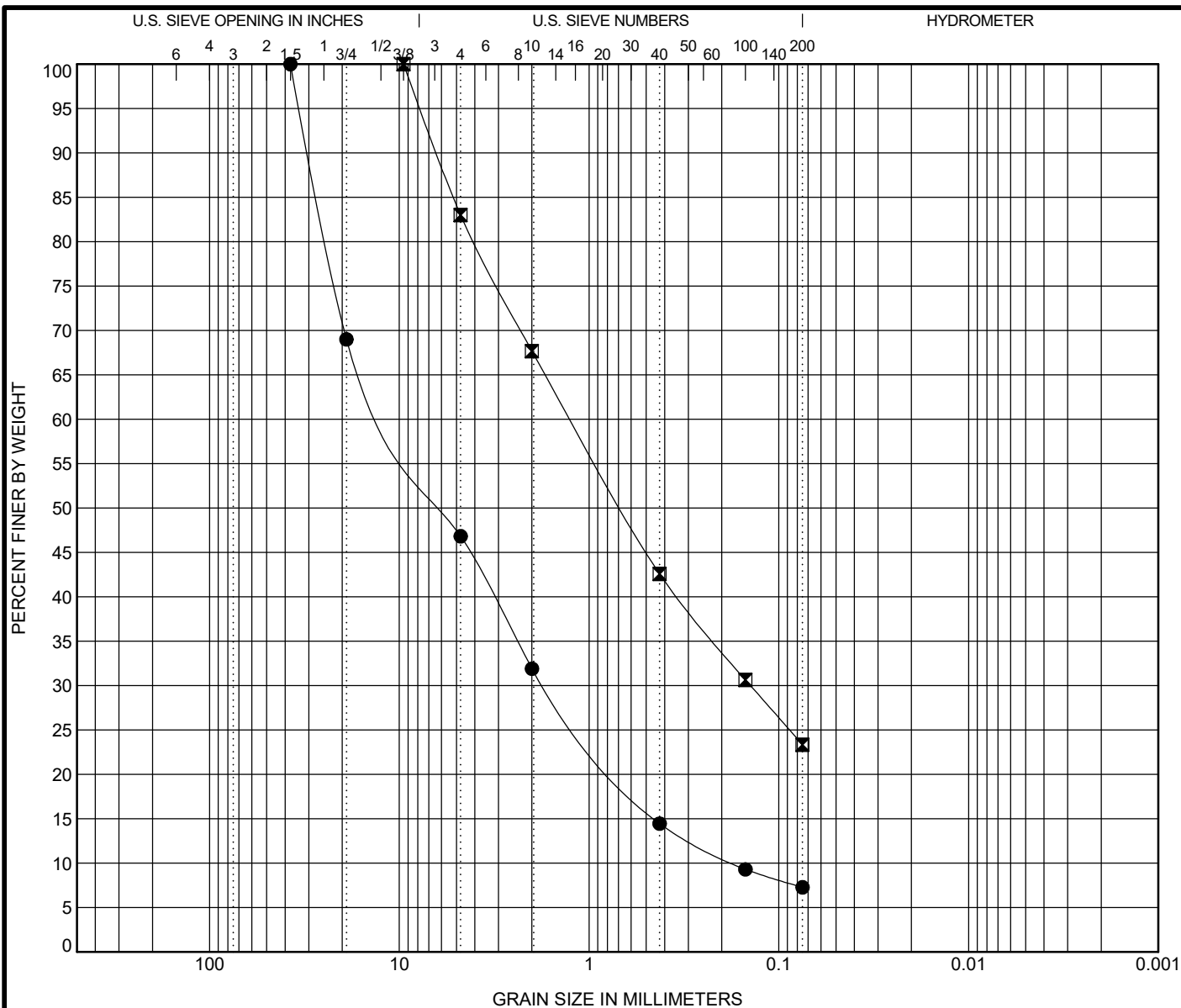
GRAIN SIZE DISTRIBUTION

Project No: 13018.02

Date: 7/14/25

Project: Arlington CSD - LaGrange Middle School

Location: LaGrangeville, NY



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Sample Identification				Classification				WC%	LL	PL	PI	Cc	Cu
●	B-26	4.0	S-3	Bwn c-f GRAVEL, and c-f Sand, trace Silt				5.5				1.53	62.62
☒	B-3	2.0	S-2	Bwn c-f SAND, some Silt, little f Gravel				7.9					

Sample Identification				D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay	Source of Material	
●	B-26	4.0	S-3	37.5	10.828	1.69	0.173	53.2	39.5	7.3		Boring	
☒	B-3	2.0	S-2	9.5	1.245	0.141		17.0	59.7	23.3		Boring	

Tectonic

280 Little Britain Road, Bldg. 2
Newburgh, NY 12550
Telephone: (845) 563-9081

Fax: (845) 563-9085

GRAIN SIZE DISTRIBUTION

Project No: 13018.02

Date: 7/14/25

Project: Arlington CSD - LaGrange Middle School

Location: LaGrangeville, NY

Soil Test Report

Lab #: 2025- 26103

Tectonic Engineering - Villa
Ryan Villa
1279 Route 300
Newburgh, NY 12550

Date Received: 2025-06-06

Date Reported: 2025-06-13

rvilla@tectonicengineering.com
(845)467-1245

Crop or Plant

NewTurfgrass, cool season

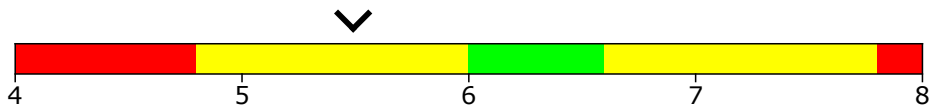
Sample ID: TS-1 WO#1301802 Arlington CSD

Results and Interpretations

Loam

pH: 5.49

Strongly acidic, suitable for the growth of blueberry or potato crops and acid-loving ornamentals such as rhododendron, holly, and spruce, but too acidic for most other plants.

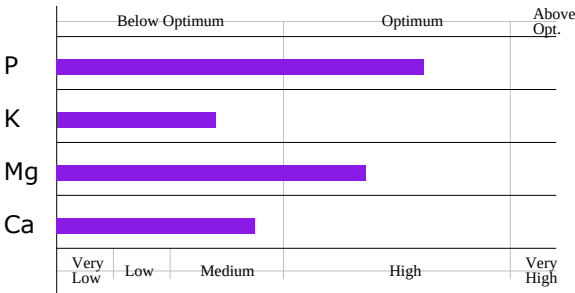


Lime Requirement Index: 7.14

The Lime Requirement Index (LRI) is a measure of the buffering capacity of the soil, its resistance to pH change, and is used to determine the appropriate amount of limestone, when necessary. LRI value near 8.0 indicates low buffering capacity of soil and a lower rate of limestone amendment compared to soil with high buffering capacity (LRI near 7.0).

Macronutrients (pounds per acre)

		by Mehlich 3 extraction
Phosphorus:	112	(Optimum)
Potassium:	106	(Below Optimum)
Magnesium:	199	(Optimum)
Calcium:	1320	(Below Optimum)



Micronutrients (parts per million)

Zinc(Zn)	Copper(Cu)	Manganese(Mn)	Boron(B)	Iron(Fe)	Sulfur(S)
2.89 (Adequate)	1.73 (Adequate)	62.94 (High)	0.68 (Low)	159.00 (High)	13.00 (Medium)

Special Tests Results

Soluble Salts- Electrical conductivity= 0.10 mmho/cm

(Satisfactory)

Organic Matter by Carbon Analysis: Organic Matter=3.8%

High for Loam

Gravel Content- Larger than 2mm: 56.4%

Mechanical Analysis- Sand= 51% Silt=36% Clay= 12% Texture: Loam

Measured Cation Exchange Capacity: 11.22 meq/100g

pH, Calcium, and Magnesium Recommendations

The soil pH is below the optimum range of 6.00 to 6.60 for the growth of most Turfgrass, cool season.

To optimize the soil condition, it should be treated with 95 pounds per 1000 square feet using calcitic limestone. For new plantings this may be applied in a single operation spread uniformly on the surface, then mixed thoroughly to a 6 in. depth by shovel or tilling. Do not apply more than the recommended amount until the soil is tested again.

Fertilizer Recommendations

Reported management conditions: Light-Partial Shade Irrigation-Weekly Clippings-

LATE SUMMER OR EARLY FALL is the best time to establish cool-season grasses. EARLY SPRING establishment can also be successful but is riskier and may require more input of effort and resources. N.J. law prohibits application of fertilizer containing nitrogen or phosphorus after November 15 (December 1 for professional certified applicators) and before March 1.

Target ratio for fertilizer product is: 1:2:3 ,which represents the fertilizer?s relative amounts of nitrogen (N), phosphorus as P_2O_5 , and potassium as K_2O .

The estimated yearly nitrogen (N) need of this new seeding/sodding is 1 pound per 1000 square feet. New plantings allow mixing of the fertilizer into the soil to build up root zone fertility before planting.

DO THIS: Uniformly apply fertilizer(s) with N:P:K ratio indicated above to achieve 0.9 pound Nitrogen per 1000 square feet, and mix into soil depth of 4 inches.

TWO to FOUR WEEKS AFTER EMERGENCE of seedlings or placing sod, additional fertilizer is recommended to promote rapid establishment. If seeding/sodding in spring, this application should be repeated in September and October, at least 5 weeks apart; or for sandy soils, split applications into half-rate and apply four times, 3 weeks apart.

Rutgers Cooperative Extension encourages use of fertilizers having a water-insoluble nitrogen (WIN) component as specified on the label. WIN serves as a slow, extended release source of nitrogen. A gentle rain or light watering after application will help rinse fertilizer into the root zone, but do not apply fertilizer just prior to expected heavy rainfall to avoid loss of fertilizer and pollution of stormwater.

DO THIS: Using a 2:1:1 fertilizer, apply 0.75 pound Nitrogen per 1000 square feet spread uniformly over the turf.

WHAT ABOUT NEXT YEAR? In the 2nd year of establishment, two periods of fertilization are suggested: 1) April, and 2) September. Avoid applying fertilizer during very hot, very dry weather. For sandy soils, it is also suggested that each application be split into two doses spaced 3 to 5 weeks apart to minimize potential for leaching loss.

The fertilizer prescription above is intended to bring soil nutrients to optimal or near-optimal conditions, and subsequent management recommendations are intended to maintain soil nutrients levels near optimum. A gentle rain or light watering after application will help rinse fertilizer into the root zone, but do not apply fertilizer prior to expected heavy rainfall to avoid loss of fertilizer and pollution of stormwater.

The best nutrient ratio for maintenance fertilization of the turf beyond 2 years is best determined by another soil test.

DO THIS: return grass clippings to the Turfgrass when mowing to recycle nutrients. Use fertilizer with N:P:K ratio of: 1:0:0 (nitrogen only) or 4:0:1 or 2:0:1 or 1:0:1 (representing increasing amounts of potassium; doses of potassium may be necessary for sandy, low organic matter soils) to achieve 0.75 pound Nitrogen per 1000 square feet.

How do I find the proper fertilizer product?

For help finding appropriate fertilizers and rates, consult the Rutgers Soil Testing Laboratory website: <https://itsappserver.sebs.rutgers.edu/FertProducts/>. The website lists commercially available products according to their nutrient analyses to assist you with product selection and calculation of amount required.

Select a fertilizer that has a nutrient grade (also known as guaranteed minimum analysis) the same as or a multiple of the values recommended, or select a close match to that ratio. When no single fertilizer product matches or approximates the recommended N:P₂O₅:K₂O nutrient ratio, it will be necessary to use two or more fertilizers to reach the correct balance of nutrients. The proper amount of fertilizer to apply in a single application depends on the actual fertilizer grade of the fertilizer product selected, the total area (square feet) to be treated, and the total number of fertilizer applications to be made throughout the year.

Micronutrient Statements

Zinc does not appear to be a limiting factor. For information about zinc in soil for plant nutrition, see FS721.

Copper does not appear to be a limiting factor. As with most other micronutrients, copper availability is related to soil pH. Do not over-lime. For more information about soil copper, see FS720.

Manganese may be toxic to sensitive crops when grown on low pH soil. Adding lime to the soil raises the pH and decreases manganese toxicity. Liming is generally not recommended for acid-loving plants, which are more tolerant of high levels of manganese. In excessive amounts, soil manganese can cause plant damage. This occurs primarily in low pH soil. Lime soil as recommended to decrease availability of manganese to plants. Avoid fertilizers that contain manganese. See FS973 for more information.

Plant types differ in their susceptibility to boron deficiency; certain fruit, vegetable, and field crops are most susceptible. Symptoms include improper development or dieback of growing tips, poor flowering or fruit set, twisting and yellowing of young leaves from base to tip, and black heart of roots. Lime only as necessary, since pH above 7.0 limits boron availability. Building up organic matter content of soil will increase boron availability. Use of boron fertilizer must be done only with extreme care because of the toxicity that might occur if over-applied and the difficulty of applying the low rates necessary. See FS873 for more information and follow recommendations above.

Plant availability to iron is highly dependent on soil pH. Although soil iron appears plentiful, high soil pH could limit its availability. On the other hand, plant damage due to iron toxicity, though not common, could occur at low soil pH

(acidic soil). Maintain soil pH in the optimum range as described in Recommendations. See FS971 for more information.

Although soil tests for sulfur fertility must be interpreted with many considerations in mind, the soil test value suggests potential for sulfur deficiency within the soil depth sampled for certain crops at the time the sample was taken. Agronomic crops, legumes, and vegetables in the Brassicaceae (cabbage) family or Allium (onion) genus are most likely to express sulfur deficiencies. For these crops, response to sulfur fertilization is likely. Some N-P-K fertilizers also contain sulfur that will meet most plants' requirements. Organic matter decomposition is the natural source of plant-available soil sulfur (sulfate ion). Sulfate is susceptible to leaching, and so sandy, low organic matter-soils are most prone to sulfur deficiency. Deficiencies may be time- and weather-dependent, such as in spring when cold soil limits decomposition and leaching from frequent rainfall is most likely. However, deep-rooted vegetation may have access to sulfur in subsoil/depths greater than sample taken; a separate sample from the subsoil would help assess need for added S. For long-term fertility, incorporate best management practices to maintain adequate organic matter content in soil. For additional information on sulfur fertility, see Rutgers Cooperative Extension bulletin E365.

Comments:

Find Rutgers Cooperative Extension Fact Sheets at www.njaes.rutgers.edu/pubs



Our Story

For the past 30 years, Tectonic has delivered quality professional services in a timely and cost effective manner by pooling its talented staff into project teams that think, act, and perform as one integral unit. By carefully listening and collaborating with its clients, the firm is able to identify the key issues and assure stakeholder objectives are met in the final deliverables. Through innovating and adopting technological advances, the firm is able to generate unique solutions to improve our nation's deteriorating infrastructure and build safe sustainable communities.

As the world evolves, and its challenges grow more complex, Tectonic continues to innovate and provide the practical solutions and exceptional customer service its clients have trusted since its founding.

SECTION 31 23 19 - DEWATERING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes construction dewatering.
- B. Related Requirements:
 - 1. Section 312000 "Earth Moving" for excavating, backfilling, site grading, and controlling surface-water runoff and ponding.

1.3 ACTION SUBMITTALS

- A. Shop Drawings: For dewatering system, prepared by or under the supervision of a qualified professional engineer.
 - 1. Include plans, elevations, sections, and details.
 - 2. Show arrangement, locations, and details of wells and well points; locations of risers, headers, filters, pumps, power units, and discharge lines; and means of discharge, control of sediment, and disposal of water.
 - 3. Include layouts of piezometers and flow-measuring devices for monitoring performance of dewatering system.
 - 4. Include written plan for dewatering operations including sequence of well and well-point placement coordinated with excavation shoring and bracings and control procedures to be adopted if dewatering problems arise.

1.4 INFORMATIONAL SUBMITTALS

- A. Existing Conditions: Using photographs and/or video recordings, show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by dewatering operations. Submit before Work begins.

1.5 CLOSEOUT SUBMITTALS

- A. Record Drawings: Identify locations and depths of capped wells and well points and other abandoned-in-place dewatering equipment.
- B. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer that has specialized in dewatering work.

1.7 FIELD CONDITIONS

- A. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of a geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by a geotechnical engineer. Owner is not responsible for interpretations or conclusions drawn from this data.
 - 1. Make additional test borings and conduct other exploratory operations necessary for dewatering according to the performance requirements.
 - 2. The geotechnical report is included elsewhere in Project Manual.
- B. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.
 - 1. Design dewatering system, including comprehensive engineering analysis by a qualified professional engineer.
 - 2. Continuously monitor and maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, prevention of flooding in excavation, and prevention of damage to subgrades and permanent structures.
 - 3. Prevent surface water from entering excavations by grading, dikes, or other means.
 - 4. Accomplish dewatering without damaging existing buildings, structures, and site improvements adjacent to excavation.
 - 5. Remove dewatering system when no longer required for construction.

- B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning dewatering. Comply with water- and debris-disposal regulations of authorities having jurisdiction.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.
 - 1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site or surrounding area.
 - 2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.
- B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- C. Provide temporary grading to facilitate dewatering and control of surface water.
- D. Protect and maintain temporary erosion and sedimentation controls, which are specified in Section 312500 "Erosion and Sediment Controls (SPDES)," during dewatering operations.

3.2 INSTALLATION

- A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.
 - 1. Space well points or wells at intervals required to provide sufficient dewatering.
 - 2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.
- B. Place dewatering system into operation to lower water to specified levels before excavating below ground-water level.
- C. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.
- D. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails.

3.3 OPERATION

- A. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.
- B. Operate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.
 - 1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.
 - 2. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.
 - 3. Maintain piezometric water level a minimum of 24 inches (600 mm) below bottom of excavation.
- C. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others.
- D. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches (900 mm) below overlying construction.

3.4 PROTECTION

- A. Protect and maintain dewatering system during dewatering operations.
- B. Promptly repair damages to adjacent facilities caused by dewatering.

END OF SECTION 31 23 19

SECTION 31 25 00 - EROSION AND SEDIMENTATION CONTROLS (SPDES)**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Erosion, sediment and pollution controls as shown on the Drawings and as directed by the Engineer (qualified professional) to significantly reduce runoff on downstream properties. This includes temporary control measures to mitigate land disruption by other contractors during construction of this project.
 - a. Qualified Professional: Is a licensed professional engineer, a registered landscape architect, or a certified professional in erosion and sediment control.
2. Erosion, sediment and pollution control includes, but is not limited to, the following:
 - a. Standard control measures such as storm structure protection, silt fence, silt fence dikes, and rip rap.
 - b. Off site sediment tracking controls.
 - c. Sedimentation basin.
 - d. Seeding, sodding and erosion control fabric.
 - e. Rock check dam, sediment trap and detention basin with weir.
 - f. Temporary protection for existing vegetation.
 - g. Clean up.
3. Comply with the Stormwater Pollution Prevention Plan (SWPPP) for this Project in consultation with appropriate local agencies and soil conservation service. *Any local or State Agency requirements are considered part of these specifications.*

B. Related Sections

1. Section 31 10 00 – Site Clearing
2. Section 31 20 00 – Earth Moving
3. Section 32 12 16 – Asphalt Paving
4. Section 32 92 00 – Turf and Grasses
5. Section 33 41 00 – Storm Utility Drainage Piping

1.3 CODE COMPLIANCE

- A. The New York State Department of Environmental Conservation (NYSDEC) requires a SPDES General Permit for Storm Water Discharges from Construction Activity that disturbs one (1) acre of land or more. This Permit GP-0-20-001 is pursuant to the Environmental Conservation Law and has penalties and fines related to violations.

1.4 SUBMITTALS, GENERAL

- A. General: Submit all action submittals and informational submittals required by this section concurrently.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product listed.
 - 1. Filter fabric and hardware cloth for storm structure protection.
 - 2. Silt fence and silt fence dikes.
 - 3. Straw bales.
 - 4. Stakes.
 - 5. Erosion control blanket.
 - 6. Turf reinforcement matting.
 - 7. Bonded fiber matrix.
 - 8. Soil stabilization fabric for off-site sediment tracking control.
 - 9. Channel drain inlet filter matting
 - 10. Drop-In Inlet Protection.
- B. Material Certificates: Materials certificates showing content/mechanical analysis are required for the following products.
 - 1. Seeding & Sodding.
 - 2. No. 4 stone for off-site sediment tracking control.

1.6 QUALITY ASSURANCE

- A. Perform erosion, sediment and pollution control in compliance with the Contract Documents and applicable requirements of the New York Standards and Specifications Erosion and Sediment Control and other governing authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Handle and store products according to manufacturer's written instructions.

1.8 NOTICES

- A. The Owner will file with the NYSDEC a Notice of Intent (NOI) a minimum of five (5) days prior to start of construction. Unless notified by the NYSDEC to the contrary within five (5) days, a General SPDES Construction Permit is automatically issued which authorizes discharge of storm water on the construction site.

- B. Pre-Construction Conference: Within seven days of start of construction, attend Civil/Structural Preconstruction Meeting. Representatives of all Contractors responsible for earthwork operations are required to attend.
- C. Each Contractor responsible for soil disturbances shall identify at least one person from their company that will be responsible for implementation of the SWPPP. This person shall be known as the *Trained Contractor*. Each Contractor shall ensure that at least one *Trained Contractor* is on site on a daily basis when soil disturbance activities are being performed.
- D. When the site has been finally stabilized, Contractor shall notify the Architect, in writing, that a final inspection be performed. Upon satisfactory completion of this inspection, the Owner will file with the NYSDEC a Notice of Termination (N.O.T.).
- E. The Owner is responsible for payment of annual fees related to the SPDES permit. Filing of a NOT shall typically terminate the Owner's fee responsibility.
- F. Pay any fines issued by any agency as a result of non-compliance with the SWPPP or SESC Plans.
- G. Duty to Comply: The Owner must comply with all conditions of the SPDES General Permit. All contractors and subcontractors associated with the Project must comply with the terms of the SWPPP. Any non-compliance with the permit constitutes a violation of the Clean Water Act (CWA) and the Environmental Conservation Law (ECL) and is grounds for enforcement action against the Owner and/or the contractor/subcontractor; permit revocation, suspension or modification; or denial of a permit renewal application. Upon a finding of significant non-compliance with the permit or the applicable SWPPP, the DEC may order an immediate stop work to all construction activity at the site until the non-compliance is remedied.

1.9 INSPECTIONS AND MAINTENANCE

- A. When construction activities are on-going, the Licensed Professional Engineer, Registered Landscape Architect, Certified Professional in Erosion and Sediment Control, or qualified personnel of the Owner shall review disturbed areas of the construction site at least once every seven (7) calendar days. For construction sites where soil disturbance activities have been temporarily suspended (e.g. winter shutdown) and temporary stabilization measures have been applied to all disturbed areas, the qualified inspector shall conduct a site inspection at least once every thirty (30) calendar days. Reviews shall include, but not be limited to discussion of schedule, observation of areas not finally stabilized, effectiveness of control measures, corrective measures and violations. Special attention will be focused on areas not finally stabilized, structural control measures, and locations where vehicles enter or exit the site. Disturbed areas will be inspected for pollutants entering the drainage system. Structural control measures will be reviewed for effectiveness in preventing significant impacts to receiving waters. Locations where vehicles enter or exit the site will be inspected for evidence of off site sediment tracking. A written report of construction reviews shall be produced during construction operations.
- B. Provide timely maintenance of vegetation erosion and sediment control measures, and other protective measures, during construction. Keep a written record of maintenance and corrective work in a journal. The journal shall be added to the on site SWPPP.

- C. Maintain a field copy of the General Permit, NOI, NOI Acknowledgement Letter, SWPPP, inspection reports, and erosion control maintenance logs at the construction site until all disturbed areas have achieved final stabilization and the NOT has been submitted to the DEC. The documents must be maintained in a secure location, such as a job trailer, on-site construction office, or mailbox with lock. The secure location must be accessible during normal business hours to a representative of the Owner, Engineer, and NYSDEC.
- D. Perform corrective measures within three (3) calendar days of the Engineer's or Owner's report at no cost to the Owner. Failure by the Contractor to perform corrective work within this schedule automatically authorizes the Owner to hire others and deduct from the Contract Sum the costs incurred by the Owner for the performance of this Work.
- E. The Owner shall provide long term maintenance of the storm water facilities after Notice of Termination has been issued. The designated maintenance personnel shall keep written records of maintenance and corrective work in a journal. The journal shall be added to the on site SWPPP.
- F. *The Owner* shall retain a copy of the NOI, NOI Acknowledgment Letter, SWPPP, MS4 SWPPP Acceptance Form, NOT, and any inspection reports that were prepared in conjunction with this permit for a period of at least five (5) years from the date that the site achieves final stabilization.

PART 2 - PRODUCTS

2.1 STORM SEWER PROTECTION

- A. 1/2-inch mesh hardware cloth covered with a polypropylene silt fence fabric.

2.2 STRAW BALES

- A. Clean, free of dirt, hay, grass, or weeds.
- B. Bound with twine or wire.
- C. Bales, when placed, shall be dry and capable of passing water.

2.3 SILT FENCE

- A. Meet the following criteria unless specific type is shown on plans or Architect accepts the change in criteria.
 - 1. Silt Fence: Polypropylene filter fabric supported by non-pressure treated hardwood posts meeting the following requirements.

Property	Unit	Test Method	Value
Grab Tensile Strength (Machine Direction)	lbs	ASTM D 4632	124 min
Grab Tensile Strength (Cross-Machine Direction)	lbs	ASTM D 4632	124 min
Grab Tensile Elongation	%	ASTM D 4632	15 / 15
Trapezoid Tear Strength	lbs	ASTM D 4533	65 min

Mullen Burst Strength	psi	ASTM D 3786	300 min
Puncture Strength	lbs	ASTM D 4833	60
Ultraviolet Stability (Strength Retained)	%	ASTM D 4355	70
Apparent Opening Size (AOS)	U.S. Sieve	ASTM D 4751	30
Permittivity	sec ¹	ASTM D 4491	0.10
Coeff of Permeability	CM/Sec	ASTM D 4491	0.005 min
Water Flow Rate	gal/min/ft ²	ASTM D 4491	25 min

2. Basis of Design Product: Subject to compliance with requirements provide Tencate Geosynthetics Mirafi 100X fabric or comparable product.
3. Reinforced fence: Fabric backed with 14-1/2 gauge by 6-inch square mesh woven wire. See plans and details for specific locations or requirements.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. DGI Industries.
2. Hanes Geo Components.
3. TenCate Geosynthetics (Mirafi).

2.4 STAKES

A. One of the following:

1. 2-inch by 2-inch nominal by 4-feet long, non-pressure treated hardwood.
2. #4 rebar, 4-feet long min.

B. Maximum post spacing permitted shall be: 8-ft 4-in O.C.

2.5 STONE FILTERS

A. Size shown on the plans meeting the requirements of ASTM C33 or State specifications where applicable.

2.6 PERMANENT SEEDING AND SODDING

A. Refer to applicable section.

2.7 TEMPORARY SEEDING (unless otherwise shown on Drawings):

A. Minimum requirements:

1. Lime: 1/2 ton per acre.
2. Fertilizer: Commercial 5-10-10 or equivalent (600 lbs per acre).
3. Seed: Ryegrass (annual or perennial) (40 lbs. per acre).
4. Mulch: Straw at 2 ton per acre.

2.8 EROSION CONTROL BLANKETS

- A. On Slopes 3:1 and Flatter – Netless Biodegradable Blanket: 100% biodegradable stitched excelsior erosion control matting. (Netted erosion control fabric on slopes 3:1 and flatter is not allowed.)

1. Material Characteristics:

- a. Soil loss ratio: .063
- b. Fiber Size: 80% of fibers min. of 6 inches long
- c. Weight: 0.73 lb per square yard.
- d. Channel Flows: Suitable for channel flows up to 3.0 ft./second and 1.0 lb/ft. shear stress.

2. Staples: Use manufacturer provided staples.

3. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

- a. “Curlex NetFree” Erosion Control Blanket manufactured by North American Green.

- B. On Slopes Steeper than 3:1 up to 1.5:1 – 100% biodegradable excelsior erosion control matting with polypropylene netting containing a UV degrader additive.

1. Material Characteristics:

- a. Fiber Count: 7,000 per square yard.
- b. Fiber length: 80% of fibers min. of 6” long
- c. Net Openings: 1.0 inch x 2 inches
- d. Thickness: 0.411 inch per ASTM D 6525
- e. Swell: 49% per ECTC Procedure
- f. MD-Tensile Strength Max.: 74.4 lb./ft. per ASTM D 6818
- g. TD-Tensile Strength Max.: 36.0 lb./ft. per ASTM D 6818

2. Staples: Use manufacturer provided staples.

3. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

- a. “Curlex I QuickMow” Erosion Control Blanket manufactured by North American Green.

2.9 TURF REINFORCEMENT MATTING

- A. Permanent erosion control/turf reinforcement mat constructed of a matrix of polypropylene monofilament yarns woven into uniform configuration of resilient pyramid-like projections.

1. Material Properties:

Property	Test Method	Units	Property Requirement
Thickness	ASTM D-6525	mm (in)	10.2 (0.40)
Resiliency	ASTM D-6524	percent	80
Mass Per Unit Area	ASTM D-6566	G/sq m (oz/sy)	455 (13.5)
Tensile Strength	ASTM D-6818	kN/m (lbs/ft)	58.4 x 43.8 (4,000 x 3,000)
Tensile Elongation	ASTM D-6818	percent	65 (max)
Light Penetration (% Passing)	ASTM D-6567	percent	10
UV Resistance	ASTM D-4355	percent	90 at 6000 hrs

2. Performance Properties: In a vegetated state, the RECP must demonstrate acceptable performance (as defined by the Engineer) when subjected to at least 0.5 hrs of continuous flow producing the following conditions:
- Permissible velocity: 7.6 m/sec (25 ft/sec)
 - Permissible tractive force (shear stress): 0.718 kPa (15 psf)
3. Color: Green.
4. Basis of Design Product: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
- Pyramat Geotextile System by Propex, Inc.

2.10 BONDED FIBER MATRIX

- Hydraulically applied continuous layer of biodegradable elongated fiber strands held together by a water-resistant bonding agent with no holes greater than one millimeter in size.
- Physical Components:
 - Ingredients/Composition:
 - Gypsum-based, soil beneficial binder
 - Cellulosic fiber mulch (paper/soft wood)
 - Plant-based tackifiers (short-term binding agents)
 - Nonpetroleum-based polymers (long-term binding agents)
 - Surfactant
 - Water-holding polyacrylamides (PAM)

C. Physical Properties:

1. Moisture: 10% (+/- 2%)
2. pH: 5.5 – 6.5
3. Mix: 70lbs (+/-10 lbs.) per 100 gallons of water (Recommended)
4. Color: Green
5. Wood/Cellulose Fiber: 70% / 30%
6. Water Holding ASTM D 7367-07: 850-950%
7. Water Holding ASTM Modified Method: 1200 – 1400%

D. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. “Enviro-Shield” Brand Bonded Fiber Matrix by USG.
2. “Flexterra” by Profile Products, LLC.

2.11 STABILIZED CONSTRUCTION ENTRANCE

A. No. 4 stone meeting the following requirements:

<u>Standard ASTM Sieve Size</u>	<u>Percent Passing by Weight</u>
4 inch	100
3 inch	90-100
2 inch	0-15
Passing No. 50	5-10
Passing No. 100	2-5

B. Soil Stabilization Fabric:

1. Stabilization Fabric: A commercially manufactured, UV stabilized low clogging, high flow, woven geotextile meeting the following requirements.

<u>Property</u>	<u>Unit</u>	<u>Test Method</u>	<u>Value</u>
Grab Strength	lbs	ASTMD-4632	315 min
Tensile Strength	lbs/in	ASTMD-4595	175 min
Grab Elongation	%	ASTMD-4632	15 max
Trapezoid Tear	lbs	ASTMD-4533	120 min
Mullen Burst	psi	ASTMD-3786	600 min
Permittivity	/Sec	ASTMD-4491	.05min
Water Flow Rate	gal/min/ft ²	ASTMD-4491	4 min

2. Basis of Design Product: Subject to compliance with requirements, provide TenCate Geosynthetics, Mirafi 600X fabric or comparable product.
3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. DGI Industries.
- b. Hanes Geo Components.
- c. TenCate Geosynthetics (Mirafi).

C. Granular Base Course Material: Shall be as specified in Earth Moving Section.

2.12 TEMPORARY TREE PROTECTION

- A. Stakes: 2 inch by 4 inch x 6 foot (min) non-pressure treated hardwood.
- B. Top Rail: 2 inch by 4 inch x 8 foot (max) non-pressure treated hardwood fastened to stakes by nails or screws.
- C. Fabric:
 - 1. Heavy duty orange construction barrier fencing.
 - 2. Basis of Design Product: Subject to compliance with requirements, provide Tenax Corporation "Sentry HD" fencing or comparable product.
 - 3. Fabric shall be attached to the stakes and top rails with staples or other fasteners.

2.13 OUTLET SEDIMENTATION TRAP

- A. Outlet Sedimentation Trap: Constructed of 12 inch pipe, AASHTO M294-Type S or SP corrugated HDPE N-12 pipe and stone as shown in the Drawings. Filter fabric shall be as specified for siltation fence. Hardware cloth shall be ½ inch mesh. Concrete shall be 4,000 psi.

2.14 CONCRETE WASHOUT

- A. Provide concrete washout as specified.

2.15 ROCK CHECK DAMS AND SEDIMENT TRAPS

- A. Provide stone rip rap as specified. Vegetation shall be as described on the Drawings.

2.16 CHANNEL DRAIN INLET FILTER MATTING:

- A. Latex bonded coir (coconut) fiber matting, 4.0 Ounces per Square-Foot, 1-1/2" thickness.
- B. Basis-of-Design product and standard of quality for channel drain inlet filter matting for use in existing and proposed channel drains shall be Natural Fiber Inlet Filter Matting, Item #IF1527X75FTB, by Blocksom & Co., Michigan City, Indiana. Telephone: 800-745-1408. Web: www.blocksom.com

C. Physical Properties: (4-inch wide strip specimen)

1. Fiber Material
 - a. Latex bonded coir (coconut) fiber matting
 - b. Nominal 4.0 ounces / square-foot, 1½” thickness.
2. Sediment Control per ASTM D 5141
 - a. Test Material: Sand sieved through No. 10 sieve
 - b. Efficiency: 59.1%
 - c. Minimum flow rate: 150 liters/minute
3. Tensile Properties per ASTM D 5035/ECTC
 - a. MD – Maximum Load: 14.6 ppi
 - b. TD – Maximum Load: 18.7 ppi
 - c. MD – Elongation at Max Load: 19.3%
 - d. TD – Elongation at Max Load: 27.7%
4. UV Resistance per ASTM D 4355 – 500 hr exposure
 - a. MD – Maximum Load: 10.2 ppi
 - b. TD – Maximum Load: 13.8 ppi
 - c. MD – Elongation at Max Load: 16.9%
 - d. TD – Elongation at Max Load: 16.6%
5. Smolder Resistance (ECTC)
 - a. Maximum Burn Distance: 0.29 in
6. Light Penetration (ECTC Guidelines)
 - a. Baseline Reading: 125
 - b. Reading with Sample: 10
 - c. Percentage Light Penetration: < 8%
7. Resiliency per ASTM D 6524
 - a. Pre-Loading Thickness: 1943 mils
 - b. Post-Loading Thickness: 326 mils
 - c. Percentage Change: -83%
8. Swell (ECTC)
 - a. Dry Thickness: 1984 mils
 - b. Thickness after Soak: 2098 mils
 - c. Percentage Change: 6%

9. Water Absorption per ASTM D 1117/ECTC

- a. Pre-Soak Weight: 69 grams
- b. Post-Soak Weight: 152 grams
- c. Weight Change: 82 grams
- d. Percentage Weight Change: 119%

10. Mass/Unit Area per ASTM D 6565

- a. Mass/unit area: 50.89 oz/sq yd
- b. Mass/unit area: 1725 g/sq meter

11. Filter Mat Filter Cable Ties

- a. Heavy duty “zip” cable ties provided by filter manufacturer and designed specifically for inlet filter product, and in quantity required for manufacturer recommended installation method.

2.17 DROP-IN INLET PROTECTION

- A. Standard of quality for aftermarket inlet protection for use in existing and proposed catch basin, drop inlets, curb box inlets and storm manholes shall be Flexstorm Inlet Filters, by Inlet and Pipe Protection, Inc., Naperville, Illinois.

1. Description of System:

- a. An aftermarket drop-in inlet filter system designed to collect silt and sediment from surface storm water runoff at drainage locations shown on the plans, at existing inlets in pavement where adjacent disturbance will allow sediment runoff to occur, in areas where access to the site dictates their use due to phasing issues, or as directed by the Engineer.
- b. An aftermarket drop-in inlet filter system comprised of a corrosion resistant steel frame and a replaceable geotextile sediment bag attached to the frame with a stainless steel locking band. The sediment bag hangs suspended from the rigid frame at a distance below the grate that shall allow full water flow into the drainage structure if the bag is completely filled with sediment.
- c. The aftermarket drop-in inlet filter frame includes lifting handles in addition to the standard overflow feature. A proprietary Removal Tool engages the lifting bars or handles to allow manual removal of the assembly without machine assistance. The frame suspension system is adjustable in ½” increments up to 5” per side on rectangular designs should the casting or drainage structure have imperfections.
- d. Standard woven polypropylene sediment bags with a typical flow rate of 200 gpm / sq ft.

2. Woven Sediment Bag Material Specifications:

		MARV ²	
PROPERTY	TEST METHOD	ENGLISH	METRIC
Mechanical			
Tensile Strength (Grab)	ASTM D-4632	255 x 275 lbs	1130 x 1220 N
Elongation	ASTM D-4632	20 x 15 %	20 x 15 %
Puncture	ASTM D-4833	135 lbs	600 N
Mullen Burst	ASTM D-3786	420 psi	2890 kPa
Trapezoidal Tear	ASTM D-4533	40 x 50 lbs	175 x 220 N
Endurance			
UV Resistance	ASTM D-4355	90%	90%
Hydraulic			
Apparent Opening Size (AOS) ³	ASTM D-4751	20 US Std. Sieve	0.850 mm
Percent Open Area (POA)	CW-02215 Mod. ⁴	20%	20%
Permittivity	ASTM D-4491	1.50 sec ⁻¹	1.50 sec ⁻¹
Water Flow Rate	ASTM D-4491	200 gpm/ft ²	8,145 l/min/m ²

3. Tested Filtration Efficiency:

- a. All testing performed in general accordance with the ASTM D 7351, *Standard Test Method For Determination of Sediment Retention Device Effectiveness in Sheet Flow Application*, with flow diverted into an area inlet. Test Soil used as sediment had the following characteristics with a nominal 7% sediment to water concentration mix:

Soil Characteristics	Test Method	Value
% Gravel	ASTM D 422	2
% Sand		60
% Silt		24
% Clay		14
Liquid Limit, %	ASTM D 4318	34
Plasticity Index, %		9
Soil Classification	USDA	Sandy Loam
Soil Classification	USCS	Silty Sand (SM)

Tested Efficiencies:

Property	Woven Sediment Bag
Filtration Efficiency	82%

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Examine conditions under which soil erosion and sediment control is to be installed notify Architect in writing of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to Installer.
- B. Beginning installation constitutes Contractor's acceptance of conditions.

3.2 SIGNATURE REQUIREMENTS

- A. Between the Pre-Construction Meeting and starting site work:
 - 1. Sign the certification statements. Prominently display the statements at the job site.
 - 2. Review inspection and maintenance procedures. Decide where SWPPP will be temporarily stored for review by NYSDEC, Owner and Architect.
 - 3. Designate specific Owner and Contractor personnel responsible for inspection and maintenance.
 - 4. Prior to the start of construction, submit schedule for completion of installation of measures identified in SESC Plan and SWPPP. **DO NOT BEGIN EARTHWORK OPERATIONS AT SITE UNTIL MEASURES IDENTIFIED IN SESC PLAN AND SWPPP HAVE BEEN ACCEPTED BY ARCHITECT AND INSTALLED AT SITE.**
 - 5. When conditions change during construction, submit revisions to the SWPPP to Owner, the Architect and other agencies identified in the SPDES permit and the SWPPP.

3.3 GENERAL EROSION CONTROL

- A. Provide initial construction erosion control features, shown in the SWPPP and as indicated on Drawings and Specifications or as directed by the Architect, prior to disturbing the site with such construction operations as clearing and grubbing, topsoil stripping, earthwork, trenching excavation and removal of existing vegetation. Keep the disturbance to a minimum. Install other features as described in the sequence of erosion, sediment and pollution control on the drawings.
- B. Minimize amount of bare soil exposed at one time. Do not disturb five (5) or more acres at one time. Disturbance of five (5) acres or more at one time requires the Contractor to obtain prior written permission from the NYSDEC to vary from the requirement of SPDES Permit GP-0-15-002. Provide written copy of approval from NYSDEC to the Owner and the Architect. Start permanent seeding within seven (7) calendar days of rough grading. When this is not possible, provide temporary seeding of perennial rye grass at the rate of three pounds seed per one thousand square feet. Provide temporary seeding within seven (7) days on non-roof, non-paved areas. When adverse weather conditions prevent good germination, repeat seeding as directed by the Architect until the area is stabilized. Till under temporary grass and fine grade when preparing for final seeding.

- C. Until a disturbed area is stabilized, trap runoff sediment by the use of debris basins, sediment basins, silt traps, or other methods acceptable to the Engineer and governing authorities. Construct sediment basins to dimensions shown on plans.
- D. Place sediment structures and or devices in accordance with dimensions shown on Drawings. If sediment structures and or devices become plugged or partially plugged, remove and replace. Cleaning of the sediment structures and or devices will only be allowed when method is reviewed by Engineer or Owner Representative and found acceptable.
- E. Provide erosion controls on slopes and swales traversing, bordering, or leaving the site. Limit the water flow to a non-erosive velocity.
- F. Do not store fill materials within fifty feet of the banks of any streams or water bodies, intermittent or perennial.
- G. Provide temporary protection for trees and shrubs as outlined and shown on drawings and described in this Section.
- H. Inspect erosion and sediment control measures immediately after each rainfall and at least daily during prolonged rainfall. Make required repairs immediately.
- I. Remove sediment deposits before they reach one-half of the height of the total height of the installed sediment structure or device. Dispose sediment in a manner that does not result in additional erosion or pollution.
- J. Provide prompt removal and disposal of rubbish and debris in accordance with the governing authorities.
- K. Provide temporary grading of drainage channels, slopes, or fills in accordance with Section 31 20 00 "Earth Moving".
- L. Coordinate temporary erosion and sediment control measures with permanent erosion control features specified elsewhere in the Contract Documents to the maximum extent possible to assure economical, effective, and continuous erosion, sediment and pollution control.
- M. Provide temporary and permanent dust controls on driving areas such as roads, bus loops, parking lots, haul roads and access points, as well as non-driving areas such as lawns and athletic fields and any other disturbed areas where damage, health hazards or traffic safety problems may occur if dust is not controlled.
- N. Temporary measures are to be removed on upon final stabilization, prior to the issuance of the Notice of Termination.

3.4 MUNICIPAL SEWER AND WETLAND EROSION CONTROL

- A. Control erosion, siltation and pollution to municipal sewers, water bodies and wetlands by taking appropriate measures such as, but not limited to, the following:
 - 1. Prevent petroleum products and excessive amounts of silt, clay, and muck from entering municipal sewers, waters or wetlands of New York State during construction.

2. Prevent fresh concrete, concrete leachate and washings from equipment and trucks, from entering municipal sewers, waters or wetlands of New York State during construction.
3. Place silt fence to control erosion at the down slope edge of disturbed areas. Place this barrier to sediments before disturbance of the ground occurs and maintain in good condition until disturbed land is heavily vegetated or otherwise permanently stabilized.
4. Seed areas of soil disturbance resulting from this Project with appropriate perennial grass seed and mulched with straw within seven calendar days as described in general erosion control. Maintain mulch until a suitable vegetative ground cover is established.

3.5 STORM STRUCTURE PROTECTION

- A. As shown on the Stormwater Pollution Prevention Plan (SWPPP) and the Soil Erosion and Sediment Control Plans (SESC), provide storm structure protection at each inlet as shown on the detail plan. Clean storm structure protection material after each storm event to permit the fabric and/or drainage stone to work effectively. Remove the drainage material when the site is stabilized and certified by the Architect and/or qualified personnel of the Owner.

3.6 SILT FENCE/STRAW BALE DIKES

- A. Locate in accordance with plans and details and as directed by the Architect. Excavate trench along the lower perimeter(s) of site, along the contract limit line, and as indicated on the Drawings. The placement of silt fence and/or bales shall consider drainage paths and intercept drainage prior to leaving site or entering storm system. Place excavated material on uphill side of trench for backfilling.
- B. Drive stakes securely into the downhill side of the trench. When prefabricated silt fence with fabric attached to stakes is used, drive stakes so that fabric is buried in the ground as detailed.
- C. Backfill trench with excavated material, so that fabric is securely buried in the ground to prevent undermining. Tamp soil.
- D. Join sections by overlapping fabric between two stakes. Set stakes simultaneously. Overlap by minimum six inches, fold, and staple to prevent sediment bypass.
- E. Attach silt fence securely to stakes spaced no more than eight feet on center. Secure fence fabric to stake with minimum three one inch staples.
- F. Provide silt fence dikes perpendicular to swale center lines in swales one and one half percent and steeper. Locate dikes at a maximum interval of fifty feet on center unless otherwise shown on drawings.
- G. Removal of silt and replacement of silt fence and/or bales shall be on going throughout the duration of the project to maintain an effective silt removing barrier.

3.7 TEMPORARY SEEDING

- A. When necessary, provide temporary seeding as described in this Section.
- B. Seedbed Preparation:
 - 1. Scarify soil if compacted.
 - 2. Remove debris and obstacles such as rocks and stumps.
 - 3. Apply lime and fertilizer.
 - 4. Apply seed uniformly by mechanical seeder or hydroseeder.
 - 5. Apply straw mulch.
- C. Provide permanent seeding as described elsewhere in the Contract Documents.

3.8 EROSION CONTROL MAT

- A. Install where indicated on Drawings. Install in accordance with manufacturers' recommendations and design details, including number and location of staples.

3.9 TURF REINFORCEMENT MATTING

- A. Install where indicated on Drawings. Install in accordance with manufacturers' recommendations and design details, including number and location of staples.

3.10 BONDED FIBER MATRIX

- A. Hydraulically install bonded fiber matrix in strict accordance with manufacturer's installation instructions at the maximum rate given.
- B. Typical Application Rates:
 - 1. <3:1 Slope: 3,000 lbs./acre
 - 2. 3:1 < 2:1 Slope: 3,500 lbs./acre
 - 3. >2:1 Slope: 4,000 lbs./acre
- C. Limitations: Do not use this product in the following conditions. Notify Architect if these conditions exist.
 - 1. Concentrated overland water flow.
 - 2. On soils that display deep-seated instabilities.
 - 3. Where soil compaction problems exist or on soils that are subjected to frost heave and/or surface peeling (loosening of top layer of soil).
- D. Store and handle material per manufacturer's requirements.

3.11 OFFSITE SEDIMENT TRACKING CONTROLS

- A. Install as detailed and shown on Drawings to eliminate tracking sediment off site. Inspect after each rain storm and at least one time per week. When sediment begins tracking off site, immediately replace stone with clean No. 4 stone to retain sediment on site. Remove fabric and stone at project completion. Complete construction of proposed final surface(s).
- B. Provide wash down areas stabilized with stone that drain into Engineer approved sediment trapping device. Do not flush into water bodies, wetlands, on site or municipal systems.

3.12 CONCRETE WASHOUT

- A. Materials in or destined for the washout area shall not contact the ground, nor shall water or other liquid discharge from the containment structure.
- B. Locate washout area a minimum of 50-ft from open channels, storm drain inlets, wetlands or water bodies.
- C. Locate washout area so that it is accessible to concrete equipment (served with a minimum 10-ft wide gravel accessway).
- D. Minimum dimensions:
 - 1. For pre-fabricated units are 4-ft by 4-ft by 1-ft deep with a minimum 4-mil polyethylene plastic liner.
 - 2. For constructed concrete washout areas are 6-ft by 6-ft by 3-ft deep, with a minimum 10-mil polyethylene liner, 2H:1V side slopes, and a 1-ft high by 1-ft wide compacted fill berm.
- E. The liner must be free of tears or holes and placed over smooth surfaces to prevent puncturing. For excavated washouts, anchor the liner underneath the berm or overtop with sandbags or concrete blocks to hold in place.
- F. Provide a sign designating the washout area, and for large construction sides, provide signs throughout directing traffic to its location.
- G. Allow washed out concrete mixture to harden through evaporation of the wastewater. Once the facility has reached 75 percent of its capacity, remove the hardened concrete by disposing offsite.
- H. Apply a new liner before reusing the station for additional washouts after maintenance has occurred.

3.13 OUTLET SEDIMENTATION TRAP

- A. Install as detailed. Remove temporary trap and install permanent end section per detail near end of project when directed by the Architect.

3.14 ROCK CHECK DAMS AND SEDIMENT TRAPS

- A. Install rip rap and vegetation as detailed on the Drawings and described elsewhere in the Contract Documents.

3.15 CHANNEL DRAIN INLET FILTER MATTING

- A. Install channel drain inlet matting per manufacturer's installation requirements.
- B. Cut matting if necessary to allow minimum 3" overlap at each side of the grate. Attach the mat to the topside of the inlet grate using cable ties.
- C. Clean silt from around channel inlet matting following each rain event and as required by the Soil Erosion and Sediment Control plans and specifications, and as dictated by the Storm Water Pollution and Prevention Plan (SWPPP). Sweep the top of mat to clear built-up silt and solids, and dispose of. Do NOT allow accumulated sediment to enter the inlet.

3.16 DROP-IN INLET PROTECTION

- A. Install channel drain / inlet drain filter matting per manufacturer's installation requirements.
- B. Clean silt from filter bag following each rain event and as required by the Storm Water Pollution and Prevention Plan (SWPPP). Do NOT allow accumulated sediment to enter the inlet.
- C. The Contractor cannot pierce, cut, remove inlet filter bag to allow discharge of turbid water to the drainage system.

3.17 TREE PROTECTION

- A. Temporary Protection for Trees and Shrubs:
 - 1. Provide temporary fencing, barricades or guards as required to protect trees and other plants, which are to remain, from above ground damage.
 - 2. Protect root system from smothering. Do not store construction materials, debris, or excavated material within drip line (outer perimeter of branches). Do not permit vehicular traffic or parking within drip line. Restrict foot traffic to prevent excessive compaction of soil over root systems.
 - 3. Should any trees or shrubs be damaged which are to be saved, arrange to have such damage treated by a licensed arborist or tree surgeon.
 - 4. Trees or shrubs which die because of the Contractor's failure to conform to the Drawings and specifications shall be evaluated by a qualified organization selected by the Owner's Representative. The removal and replacement of the tree, and the evaluation expenses shall be paid for by the Contractor. Contractor shall be required to replace the damaged tree with plant material of comparable size and quality (i.e. damaged 12 inch caliper Red Maple shall be replaced by three 4 inch cal. or four 3 inch cal. Red Maples). Substitutions for variety shall be approved by the Architect

3.18 CLEANING

- A. During the Contract and at intervals as directed by the Engineer and as erosion, sediment and pollution control procedures are completed, clear the site of extraneous materials, rubbish, and debris. Leave the site in a clean, safe, well draining, and neat condition.
- B. Clean storm ponding areas, catch basins, detention basins, and other buried structures. Clean out contaminants, sediment, rubbish, construction debris, foreign objects and accumulated floatables from chambers and ponding areas thoroughly, immediately prior to final acceptance.

END OF SECTION 31 25 00

Attachment: Certification Statement

CERTIFICATION STATEMENT

Authorized, legally responsible signatures for the General Contractor, Site Earthwork, and Landscaping Subcontractor(s) shall sign and prominently display the following certification statement at the job trailer or office during the life of the project:

"I hereby certify under penalty of law that I understand and agree to comply with the terms and conditions of the Storm Water Pollution Prevention Plan (SWPPP) and agree to implement any corrective actions identified by the qualified inspector during a site inspection. I also understand that the operator (person, persons, or legal entity which owns or leases the property on which the construction activity occurs) must comply with the terms and conditions of the most current version of the New York State Pollutant Discharge Elimination System ("SPDES") General Permit for storm water discharges from construction activities and that it is unlawful for any person to cause or contribute to a violation of water quality standards. Furthermore, I understand that certifying false, incorrect, or inaccurate information is a violation of the referenced permit and the laws of the State of New York and could subject me to criminal, civil, and/or administrative proceedings. "

1. General Contractor	Signature: _____
	Name: _____
	Company: _____
	Title: _____
	Address: _____

	Phone No.: _____
	Fax No.: _____
	E-Mail: _____
2. Site Earthwork Contractor	Signature: _____
	Name: _____
	Company: _____
	Title: _____
	Address: _____

	Phone No.: _____
	Fax No.: _____
	E-Mail: _____
3. Site Landscape Contractor	Signature: _____
	Name: _____
	Company: _____
	Title: _____
	Address: _____

	Phone No.: _____
	Fax No.: _____
	E-Mail: _____
4. Other Prime Contractor(s) (as determined by the Architect – Make additional copies as necessary)	Signature: _____
	Name: _____
	Company: _____
	Title: _____
	Address: _____

	Phone No.: _____
	Fax No.: _____
	E-Mail: _____

SECTION 32 12 16 - ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.
- B. The principle reference for materials and methods is the "New York State Department of Transportation Standard Specifications for Construction and Materials," latest edition (NYSS).

1.2 SUMMARY

- A. Section Includes:
 - 1. Hot-mix asphalt paving.
 - 2. Hot-mix asphalt paving overlay.
 - 3. Cold milling of existing hot-mix asphalt pavement.
 - 4. Hot-mix asphalt patching.
 - 5. Pavement-marking paint.
 - 6. Wheel Stops.
- B. Related Sections:
 - 1. Section 31 20 00 "Earth Moving" for subgrade and aggregate base preparation and other requirements.

1.3 SUBMITTALS

- A. General: Submit all action submittals and informational submittals required by this Section concurrently.
- B. Action Submittals:
 - 1. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.
 - a. Job-Mix Designs: For each job mix proposed for the Work.
 - b. Wheel stops.

1.4 QUALITY ASSURANCE

- A. Manufacturer and Mixing Plant Qualifications: A paving-mix manufacturer and mixing plant with NYSDOT approved materials and batch plant equipment complying with the following NYSDOT Standard Specifications:
 - 1. Section 401: Plant Production

2. Section 402: Hot Mix Asphalt (HMA) Pavements.

- B. Asphalt Paving Installer: Company specializing in performing work described in this section with minimum experience of three years.
- C. Permits: Submit certified copies of all permits obtained from local regulatory agencies and New York State Department of Transportation.
- D. Installation Requirements: Work to be performed in accordance with the following NYSDOT Standard Specifications:
 - 1. Section 402: Hot Mix Asphalt (HMA) Pavements
 - 2. Section 407: Tack Coat
 - 3. Section 490: Cold Milling
 - 4. Section 685: Epoxy Reflectorized Pavement Markings

1.5 REGULATORY REQUIREMENTS

- A. Obtain written permission and required permits from applicable agency prior to start of construction, and submit copies of permits as specified in "Submittals - Quality Control Submittals" above.

1.6 PROJECT CONDITIONS

- A. Temperature and Seasonal Limitations: Refer to NYSDOT 402-3.01 Temperature and Seasonal Limitations.
 - 1. Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, if the temperature has not been above 35 deg for 12 hours immediately prior to application or if the following minimum surface temperatures are not met.
 - 2. Minimum Surface Temperatures: Comply with NYSDOT Standard Specifications Section 402, table 402-1 – Temperature Requirements.
- B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature in accordance with NYSDOT Standard Specifications Section 685-3.02 – Atmospheric Conditions.

PART 2 - PRODUCTS

2.1 AGGREGATE SUBBASE AND BASE FOR ASPHALT PAVING

- A. Refer to Division 31 Section "Earth Moving" for aggregate subbase and base courses and for aggregate pavement shoulders.

2.2 ASPHALT PAVING MIX AGGREGATES

- A. Aggregates for binder and top course: Conform to the requirements of NYSDOT Standard Specification 401-2.02, Aggregates.

2.3 ASPHALT MATERIALS

- A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes meeting NYSDOT Standard Specifications, Section 402 (70 Series) for each pavement course and complying with the following requirements:
 - 1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
 - 2. Mixes to be placed at thickness noted on the Drawings.
 - 3. Binder Course (2-in < t < 3-in): NYSDOT No. 402.197904 (Type 3 Binder). Maximum 20% RAP permitted.
 - 4. Binder Course (3-in < t < 5-in): NYSDOT No. 402.257904 (Type 3 Binder). Maximum 20% RAP permitted.
 - 5. Shim Course: NYSDOT No. 402.058904 (Type 5 Shim). Maximum 20% RAP permitted.
 - 6. Top Course: NYSDOT No. 402.127304 (Type 6.) Maximum 20% RAP permitted.
 - 7. Top Course: NYSDOT No. 402.097304 (Type 7.) Maximum 20% RAP permitted.
 - 8. Top Course: NYSDOT No. 402.097104 (Type 7F.) Maximum 20% RAP permitted.
- B. Coatings/Fillers: Comply with New York State Department of Transportation Standard Specification, Section 702 for material designations indicated.
 - 1. Tack Coat: Emulsified asphalt
 - a. Slow setting type; NYSDOT Designation 702-3601 (SS-1h) or 702-4501 (CSS-1h).
 - b. Medium setting type; NYSDOT Designation 702-3401 (HFMS-2H) or 702-4301 (CMS-2h)
 - 2. Asphalt Cement Filler: NYSDOT Designation 702-0700.
- C. Water: Potable.

2.4 PAVEMENT MARKING PAINT

- A. Complying with NYSDOT Standard Specifications:
 - 1. Section 727-09: White and Yellow Solvent Borne Acrylic Permanent Traffic Paint
 - 2. Colors:
 - a. White for asphalt striping and signage
 - 1) Lane Markings for traffic in the same direction

- b. Yellow for traffic markings
 - 1) No parking parent / bus drop-off zones
 - 2) No parking fire lanes
 - 3) Lane Markings for opposing traffic
 - 4) Parking Stalls – Confirm with owner
 - c. Blue for the following locations:
 - 1) ADA Accessible symbol and associated ADA Accessible striping
3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- a. TM 5626 White Setfast Acrylic Traffic Marking Paint, Sherwin Williams Company, Baltimore, MD
 - b. TM 5627 Yellow Setfast Acrylic Traffic Marking Paint, Sherwin Williams Company, Baltimore, MD
 - c. TM 2133 Blue Setfast Latex Traffic Marking Paint, Sherwin Williams Company, Baltimore, MD
- B. Pavement Striping Blackout Paint: Opaque, high quality, exterior grade primer compatible with existing asphalt surface and pavement marking paint.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- a. TM 5629 Black Setfast Acrylic Traffic Marking Paint, Sherwin Williams Company, Baltimore, MD
- C. Complying with NYSDOT Standard Specifications:
1. Section 727-03: Epoxy Pavement Marking Coating Material
2. Colors:
- a. White for asphalt striping and signage
 - 1) Lane Markings for traffic in the same direction
 - b. Yellow for traffic markings
 - 1) No parking parent / bus drop-off zones
 - 2) No parking fire lanes
 - 3) Lane Markings for opposing traffic
 - 4) Parking Stalls – Confirm with owner
 - c. Lane Markings for opposing traffic Blue for the following locations:
 - 1) ADA accessible symbol and associated ADA accessible striping

3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. EpoPlex “LS 50 White”, two-component, 100% solids epoxy highway marking coating material, EpoPlex, Maple Shade, NJ 08052
 - b. EpoPlex “LS 50 Yellow”, two-component, 100% solids epoxy highway marking coating material, EpoPlex, Maple Shade, NJ 08052
 - c. EpoPlex “LS 50 Custom Color (ADA Blue)”, two-component, 100% solids epoxy highway marking coating material, EpoPlex, Maple Shade, NJ 08052
- D. Pavement Striping Blackout Paint: Opaque, high quality, exterior grade primer compatible with existing asphalt surface and pavement marking paint.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. TM 5629 Black Setfast Acrylic Traffic Marking Paint, Sherwin Williams Company, Baltimore, MD
 - b. 3M Co., St. Paul, MN www.3m.com (888-364-3577)
- E. Complying with NYSDOT Standard Specifications:
 1. Section 727-09: White and Yellow Acrylic Waterborne Permanent Traffic Paint
 2. Colors:
 - a. White for asphalt striping and signage
 - 1) Lane Markings for traffic in the same direction
 - b. Yellow for traffic markings
 - 1) No parking parent / bus drop-off zones
 - 2) No parking fire lanes
 - 3) Lane Markings for opposing traffic
 - 4) Parking Stalls – Confirm with owner
 - c. Blue for the following locations:
 - 1) ADA Accessible symbol and associated ADA Accessible striping
 3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. TM 226 White Setfast Acrylic Waterborne Traffic Marking Paint, Sherwin Williams Company, Baltimore, MD
 - b. TM 227 Yellow Setfast Acrylic Waterborne Traffic Marking Paint, Sherwin Williams Company, Baltimore, MD

- c. TM 2133 Blue Setfast Latex Traffic Marking Paint, Sherwin Williams Company, Baltimore, MD
- F. Pavement Striping Blackout Paint: Opaque, high quality, exterior grade primer compatible with existing asphalt surface and pavement marking paint.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Sherwin Williams, Co.; Cleveland, OH. www.sherwin-williams.com. (216-566-2902)
 - b. 3M Co., St. Paul, MN www.3m.com (888-364-3577)
- G. Complying with NYSDOT Standard Specifications:
 - 1. Section 727-09: White and Yellow Acrylic Waterborne Permanent Traffic Paint
 - 2. Colors:
 - a. White for asphalt striping and signage
 - 1) Lane Markings for traffic in the same direction
 - b. Yellow for traffic markings
 - 1) No parking parent / bus drop-off zones
 - 2) No parking fire lanes
 - 3) Lane Markings for opposing traffic
 - 4) Parking Stalls – Confirm with owner
 - c. Blue for the following locations:
 - 1) ADA Accessible symbol and associated ADA Accessible striping
 - 3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. TM 226 White Setfast Acrylic Waterborne Traffic Paint, Sherwin Williams Company, Baltimore, MD
 - b. TM 227 Yellow Setfast Acrylic Waterborne Traffic Paint, Sherwin Williams Company, Baltimore, MD
- H. Waterborne Pavement Marking Paint, low VOC, fast drying: Complying with NYSDOT Standard Specifications:
 - 1. Section 727-09: White and Yellow Waterborne Permanent Traffic Paint

2. Colors:
 - a. White for asphalt striping and signage
 - 1) Lane Markings for traffic in the same direction
 - b. Yellow for traffic markings
 - 1) No parking parent / bus drop-off zones
 - 2) No parking fire lanes
 - 3) Lane Markings for opposing traffic
 - 4) Parking Stalls – Confirm with owner
 - c. Blue for the following locations:
 - 1) ADA Accessible symbol and associated ADA Accessible striping
 3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. TM 2174 White Acrylic Waterborne Traffic Paint, Sherwin Williams Company, Baltimore, MD
 - b. TM 2317 Yellow Acrylic Waterborne Traffic Paint, Sherwin Williams Company, Baltimore, MD
 - c. 2014 White Hydrophast Waterborne Traffic Paint, Franklin Paint Company, Franklin, MA
 - d. 2015 Yellow Hydrophast Waterborne Traffic Paint, Franklin Paint Company, Franklin, MA
- I. Pavement Striping Blackout Paint: Opaque, high quality, exterior grade primer compatible with existing asphalt surface and pavement marking paint.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Sherwin Williams, Co.; Cleveland, OH. www.sherwin-williams.com. (216-566-2902)
 - b. 3M Co., St. Paul, MN www.3m.com (888-364-3577)

2.5 AUXILIARY MATERIALS

- A. Soil Stabilization Fabric: Refer to Section 31 20 00 "Earth Moving".
- B. Concrete Wheel Stops: Precast, air-entrained concrete, 2,500-psi minimum compressive strength, 4-1/2 inches high by 9 inches wide by 72 inches long. Provide chamfered corners, drainage slots on underside, and holes for anchoring to substrate.
 1. Dowels: Galvanized steel, 3/4-inch diameter, 10-inch minimum length.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that subgrade is dry and in suitable condition to begin paving.
- B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
 - 1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
 - 2. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
 - 3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.
 - a. Subsurface preparation shall conform to the appropriate section of NYSS.
 - 4. After rolling, test course with straight edge min. 15 ft. long. Satisfactorily eliminate any depression over 1/4" deep.
 - 5. Proceed with paving only after unsatisfactory conditions have been corrected.
- C. Beginning installation constitutes Contractor's acceptance of substrates and conditions.
- D. Cold Milling:
 - 1. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.
 - 2. Mill to a depth of [1-1/2 inches] [2 inches].
 - 3. Mill to a uniform finished surface free of excessive gouges, grooves, and ridges.
 - 4. Control rate of milling to prevent tearing of existing asphalt course.
 - 5. Repair or replace curbs, manholes, and other construction damaged during cold milling.
 - 6. Excavate and trim unbound-aggregate base course, if encountered, and keep material separate from milled hot-mix asphalt.
 - 7. Keep milled pavement surface free of loose material and dust.
- E. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 SAWCUTTING

- A. Saw cut existing pavement perpendicular to the roadway surface in neat lines. If the pavement breaks irregularly along the cut line during removal, saw cut the entire length of pavement again to achieve one uniform, straight, and neat line.

3.3 TACK COAT

- A. Apply in accordance with NYSDOT Standard Specifications Section 407-3.02.
 - 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
 - 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.
- B. Manhole and Catch Basin Frames and Grates:
 - 1. Coat surfaces of frames and grates with oil to prevent asphalt adherence to surfaces. Do not tack coat.

3.4 PATCHING

- A. Hot-Mix Asphalt Pavement:
 - 1. Preparation: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending the minimum distance shown on Drawings into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade. Apply tack coat.
 - 2. Patching: Partially fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.
 - 3. Use hot-applied joint sealant to seal new joints. Fill flush with surface of existing pavement and remove excess.

3.5 REPAIRS

- A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch in existing pavements.
 - 1. Install leveling wedges in compacted lifts not exceeding 3 inches thick.
- B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4 inch.
 - 1. Clean cracks and joints in existing hot-mix asphalt pavement.
 - 2. Use emulsified-asphalt slurry to seal cracks and joints less than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.
 - 3. Use hot-applied joint sealant to seal cracks and joints more than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.

3.6 SURFACE PREPARATION

- A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.
- B. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.
 - 1. Herbicide Application: Obtain approval of Owner before herbicide notification or application. Notify Owner's designated pesticide representative and all property neighbors not less than 48 hours in advance of any pesticide application including all herbicides, insecticides and fungicides in accordance with the School Pesticide Neighbor Notification Law, Section 409-h of New York State Education Law and Commissioner's Regulation 155.24.
- C. Tack Coat: Apply tack coat.

3.7 HOT-MIX ASPHALT PLACING

- A. Hot-Mix Asphalt Paving Application: Provide finished surface free from depressions that could collect water. Satisfactorily remove, at Contractor's expense, any depressions over 1/8" when tested with 6-foot straight edge without evidence of patching. Carry all paving to wood stripping, curbing or to location shown on Drawings.
- B. Application Over Aggregate Base:
 - 1. Heavy Duty, Auto Duty and Light Duty Asphalt Areas: Apply over aggregate base in 2 courses. Comply with New York State Department of Transportation Standard Specification, Section 401 and Section 402, for asphalt types specified.
- C. Placement: Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
 - 1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
 - 2. Spread mix at minimum temperature of 250 deg F.
 - 3. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
 - 4. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.
- D. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.
 - 1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt base course before placing asphalt surface course.

- E. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.8 JOINTS

- A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.
 - 1. Clean contact surfaces and apply tack coat to joints.
 - 2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
 - 3. Offset transverse joints, in successive courses, a minimum of 24 inches.
 - 4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."
 - 5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
 - 6. Compact asphalt at joints to a density within 2 percent of specified course density.
 - 7. Use hot-applied joint sealant to seal new joints. Fill flush with surface of existing pavement and remove excess.

3.9 COMPACTION

- A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.
 - 1. Complete compaction before mix temperature cools to 185 deg F.
- B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.
- C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
 - 1. Average Density: 96 percent of reference laboratory density according to ASTM D 6927 or AASHTO T 245, but not less than 94 percent or greater than 100 percent.
 - 2. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent or greater than 96 percent.

- D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.
- E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.
- F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.
- G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
- H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.10 INSTALLATION TOLERANCES

- A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:
 - 1. Base Course: Plus 1/2 inch, no minus.
 - 2. Surface Course: Plus 1/4 inch, no minus.
- B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:
 - 1. Base Course: 1/4 inch.
 - 2. Surface Course: 1/8 inch.
 - 3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.
- C. Pavement Surface Drainage: Pavement is to drain to catch basin, swale or other storm drainage control measure as indicated on Drawings or, if not indicated on drawings, to nearest storm drainage control measure.
- D. Pavement Remediation: If pavement surface smoothness and drainage requirements above are not met, correct to meet tolerance and performance requirements. If remediation is not acceptable to Architect, removal and replacement of area will be required. Feather and smooth edges of correction measure so that joint is invisible.

3.11 PAVEMENT MARKING

- A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.
- B. Perform work in accordance with NYSDOT Standard Specifications Section 727-09.
- C. Sweep and clean surface to eliminate loose material and dust.

- D. Surface must be clean, dry and in sound condition. Remove all oil, dust, grease, dirt, loose rust, and other foreign material to ensure adequate adhesion.
- E. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended application conditions (temperature, dew point, humidity) and rates to provide a minimum wet film thickness of 15 mils and minimum dry film thickness of 7.5 mils.
- F. Do not apply pavement marking paint to concrete surfaces with concrete sealers or efflorescence. Remove by extended weathering, etching, or abrasive blasting.

3.12 WHEEL STOPS

- A. Wheel Stops: Securely attach wheel stops to pavement with not less than two galvanized-steel dowels embedded at one-quarter to one-third points. Securely install dowels into pavement and bond to wheel stop. Recess head of dowel beneath top of wheel stop.

3.13 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.
- C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.
- D. Replace and compact hot-mix asphalt where core tests were taken.
- E. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.14 FLOOD TESTING

- A. Flood Tests: Perform flood test in the presence of the Architect using water tank truck to confirm that pavement surface smoothness and surface storm drainage requirements are met.

3.15 CLEANING AND DISPOSAL

- A. Paver and Equipment Cleaning:
 - 1. Do not clean tools and equipment used for HMA placement on the pavement surface, or near streams, ponds, drainage structures or other areas that are tributaries to waterways.
 - 2. Use an area approved by the Owner's Representative for cleaning all paving equipment and tools.
 - a. If possible, remove solid pieces of asphalt by scraping or other mechanical means prior to application of a cleaning agent.

3. If a petroleum product is used for cleaning, contain all liquid products during cleaning operations using tarpaulins, sand pads, pails, or other collection methods to prevent spillage or accidental release.
 - a. Use hand sprayers or other similar devices to minimize the amount of petroleum product applied.
 4. Properly dispose of sand and collected petroleum products as petroleum contaminated soil at no additional cost to the Owner.
- B. Remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.

END OF SECTION 32 12 16

SECTION 32 13 13 - CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Sidewalks.
2. Curbs and gutters.
3. Joint Sealant.
4. Concrete Sealer.
5. Curing materials.
6. Joint forming materials.
7. Joint Filler.
8. Sealers
9. Detectable Warning Materials.

B. Related Sections:

1. Section 03 30 00 "Cast-in-Place Concrete" general concrete mix, materials, installation and building-related concrete requirements.

1.3 SUBMITTALS, GENERAL

- A. General: Submit all action submittals and informational submittals required by this Section concurrently.
- B. Refer to Div 03 concrete section for concrete submittal requirements, material certificates and other required action and informational submittals.

1.4 ACTION SUBMITTALS

- A. Provide Product Data and Testing Information for each type of product indicated.

1. Forms
2. Form release agent
3. Sealer
4. Joint Sealant
5. Curing Compound
6. Expansion Joint Material
7. Expansion Joint Forming System
8. Detectable Warning Materials

1.5 SHOP DRAWINGS

- A. Jointing Plan: Provide shop drawing showing concrete joint layout, specifically indicating the locations of expansion, tooled and control joints.

1.6 QUALITY ASSURANCE

- A. For Installer and Manufacturer requirements, refer to Div 03 concrete section.
- B. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Build mockups of full-thickness sections of concrete paving to demonstrate typical joints; surface finish, texture, and color; curing; and standard of workmanship in the location and of the size indicated where directed by Architect and not less than 96 inches by 96 inches.
 - 2. Include full-size detectable warning in mockup.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 PREINSTALLATION MEETING

- A. Concrete Paving Preinstallation Conference: Conduct conference at Project site.
 - 1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place architectural concrete to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.
 - c. Ready-mix concrete manufacturer.
 - d. Cast-in-place architectural concrete subcontractor.
 - 2. Review concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction joints, forms and form-removal limitations, reinforcement accessory installation, concrete repair procedures, and protection of cast-in-place architectural concrete.

1.8 PROJECT CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

PART 2 - PRODUCTS

2.1 Refer to Div 03 concrete section for products, unless noted below.

2.2 FORMS

- A. Form Materials: Metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.
 - 1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less. Do not use notched and bent forms.
- B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.3 CONCRETE MATERIALS

- A. Refer to Div 03 concrete section for cementitious material, aggregates, admixtures, and other concrete materials.

2.4 FIBER REINFORCEMENT

- A. Refer to Div 03 concrete section for fiber reinforcement materials.

2.5 CURING MATERIALS

- A. Standard Concrete Curing Compound: Clear, Waterborne, Membrane-Forming Curing Compound in accordance with ASTM C 309, Type 1-D, Class B, dissipating, with fugitive dye. Minimum 2-coats required.
- B. VOC Content: Curing and sealing compounds shall have a VOC content of 200 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.6 SEALER

- A. Standard Concrete Sealer: Penetrating, Silane Sealer: Single component, 40% silane, waterbased slab sealer that forms chemical bond to the concrete. VOC compliant.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. BASF Construction Chemicals; MasterProtect H 400.
 - b. Chem Masters; Aquanil Plus 40.
 - c. Dayton Superior Corporation; Weather Worker 40% J29WB.

2.7 JOINT SEALANT

- A. Joint Sealant: Two-part, elastomeric polyurethane or polysulfide-based pourable self-leveling joint sealant complying with ASTM C 920, Type M, Grade P, Class 25, NT and CRD-C-506, Type 1, Classes A & B.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. BASF Building Systems; Sonolastic SL 2.
 - 1) Color for uncolored concrete: Limestone.
 - b. W.R. Meadows, Inc.; Deck-O-Seal Sealant.
 - 1) Color for uncolored concrete: Stone Gray.

2.8 EXPANSION JOINT MATERIALS

- A. Expansion/Isolation-Joint-Filler Strips: ½-inch rigid, extruded polystyrene insulation (at exterior walls) ASTM D 1751; asphalt-saturated cellulosic fiber, or ASTM D 1752.
- B. Plastic Expansion Joint Forming System (“Zip-Strip”): Plastic joint form plus cap.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following: (inserted space)
 - a. W.R. Meadows, Inc.; Snap-Cap.

2.9 DETECTABLE WARNING MATERIALS

- A. Ductile iron detectable warning surface plates - for handicap accessible concrete curb ramps: Ductile iron, permanently embedded, wear and corrosion resistant 18-inch/24-inch/30-inch x 24-inch ductile iron plates with raised truncated domes complying with ADA and the NYS Building Code, having a skid resistance coefficient of friction greater than 0.8.
 - 1. Physical Properties:
 - a. Slip Resistance 1.10 Dry/1.06 Wet per ASTM C-1028
 - b. Wear Resistance 7333 per ASTM C-501-84
 - c. Impact Resistance..... > 238 Newtons per ASTM D-1709
 - d. Bond Strength Adhesion to Concrete > 5000 lbs per ASTM D-482
 - e. Tensile Strength..... > 35000 lbs per ASTM A-48
 - f. Design Compliance Full Compliance with ADAAG / DOT
 - 2. Hardware:
 - a. Manufacturer approved stainless steel hardware for bolting plates together

3. Coating:
 - a. Shop-dip applied black asphaltic coating.
4. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. East Jordan Iron Works, Inc. (EJIW): Duralast Cast Iron Detectable Warning Plates.

B. Polymer Composite Detectable Warning System:

1. Polymer plastic detectable warning units – 24” wide by 24”, 36”, 48” or 60”, with integral embedment flanges.
2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ADA Solutions, Inc.; Cast in Place Truncated Dome Detectable Warning Systems.
 - b. Engineering Plastics, Inc.; Armor-Tile Cast in Place System.

2.10 CONCRETE MIXTURES

- A. Refer to Div 03 concrete section for concrete mixtures.

2.11 EXAMINATION

- A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
- B. Proof-roll prepared subbase surface below concrete paving in accordance with Section 31 20 00 “Earth Moving”. Identify soft pockets and areas of excess yielding.
1. Completely proof-roll subbase in one direction and repeat in perpendicular direction.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.
- D. Beginning installation constitutes Contractor’s acceptance of substrates and conditions.

2.12 PREPARATION

- A. Remove loose material from compacted subbase surface immediately before placing concrete.

2.13 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
- B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.

2.14 STEEL REINFORCEMENT

- A. Refer to Div 03 concrete section for steel reinforcement.

2.15 JOINTS

- A. General: Form construction, expansion/isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.
 - 1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.
- B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.
 - 1. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
 - 2. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.
- C. Expansion / Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.
 - 1. Locate expansion joints at intervals of 30 feet maximum unless otherwise indicated.
 - 2. Extend joint fillers full width and depth of joint.
 - 3. Plastic Expansion Joint Forming System ("Zip Strip"). Install so that cap of channel is flush with surrounding concrete pavement. Install per manufacturer's installation instructions. Remove plastic cap after concrete is cured.
 - 4. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.

5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
- D. Control / Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows, to match jointing of existing adjacent concrete paving unless otherwise noted:
1. Tooled / Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.
 - a. Tolerance: Ensure that grooved joints are within 3 inches either way from centers of dowels.
 2. Tooled / Grooved and Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks. Sawed joints without tooling are not allowed.
- E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

2.16 CONCRETE PLACEMENT

- A. Refer to Div 03 concrete section for concrete placement information.
- B. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.
- C. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.
- D. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
- E. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.
- F. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301, (4.3.2.1 Slump Adjustment).
 1. With each concrete mixture submittal, indicate amounts of mixing water to be withheld for later addition at Project site.
 2. Water added must not increase the water-cement ratio past the approved mix design ratio.

3. Add additional water reducer or plasticizer to mix instead of adding water to achieve flowable, workable concrete. Do not add water to concrete after adding these admixtures to mixture.
 4. Do not add water after truck is more than half empty.
- G. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
- H. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement dowels and joint devices.
- I. Screed paving surface with a straightedge and strike off.
- J. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.
- K. Machine-Placed Curbs and Gutters: Allowed only upon Architect approval. Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.
- L. Slip-Form Paving: Allowed only upon Architect approval. Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.
1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.
- M. Cold-Weather Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:
1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
 2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

N. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

2.17 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.

2.18 DETECTABLE WARNINGS

A. Cast Iron Detectable Warning Surface Plates:

1. Connection: Fasten plates together with stainless steel bolts per manufacturer's torque requirements.
2. Setting Plates: Set cast iron detectable warning plates into wet concrete in accordance with ADAAG (American Disabilities Act and Accessibility Guidelines). Tamp plates thoroughly with rubber mallet until concrete seeps through vent holes.
3. Clean off excess concrete from the plate(s) and adjust adjacent concrete to be flush with plates. Finish concrete around plates to match surrounding concrete.

B. Polymer Composite Detectable Warning System:

1. Install polymer composite detectable warning plates in accordance with manufacturer's installation instructions.
 - a. Tolerance for Opening Size between plastic plates and between plates and concrete: 1/8" max.

- b. Set plastic plates in accordance with ADAAG (American Disabilities Act and Accessibility Guidelines).
- 2. Do not cut plates. Adjust sizes of plates purchased as required for installation without cutting.
- 3. Remove all remnants of protective plastic wrapping from plates. Clean off excess concrete from the plate(s) and adjust adjacent concrete to be flush with plates. Finish concrete around plates to match surrounding concrete.

2.19 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 and 305R for hot-weather protection during curing.
- B. Slabs: Protect slabs within building from precipitation accumulation. Immediately remove water, snow or ice from surface of slabs within building regardless if source is from precipitation, construction activities, etc.
- C. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- D. Formed Surfaces: Cure formed concrete surfaces, including supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.
- E. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
- F. Cure concrete according to ACI 308.1:
 - 1. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
- G. Apply penetrating, silicane sealer per manufacturer's instructions. Do not use silicane sealer on stamped concrete.

2.20 WHEEL STOPS

- A. Securely attach wheel stops to paving with not less than two galvanized-steel dowels located at one-quarter to one-third points. Install dowels in drilled holes in the paving and bond dowels to wheel stop. Recess head of dowel beneath top of wheel stop.

2.21 FIELD QUALITY CONTROL

- A. Refer to Div 03 concrete section for field quality control information.

1. Contractor Requirements:

- a. Provide access to concrete construction for representatives of testing agency employed by Owner to perform concrete testing.
- b. Notify Architect at least four days in advance of each concrete placement to allow notification of Owner's testing agency.

2.22 REPAIRS AND PROTECTION

- A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.
- B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.
- C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
- D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 32 13 13

SECTION 32 16 40 – STONE CURBS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Stone curbs.

1.3 SUBMITTALS

- A. General: Submit all action submittals (except Samples for Verification) required by this Section concurrently.
- B. Action Submittals:
 - 1. Product Data: For the following:
 - a. Mortar materials.
 - b. Stone curbs.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of stone curb from single source with resources to provide materials and products of consistent quality in appearance and physical properties.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store stone curbs on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

1.6 PROJECT CONDITIONS

- A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace stone curb work damaged by frost or freezing.

PART 2 - PRODUCTS

2.1 CURBS

- A. Stone Curbs: Granite curbing, produced in random lengths not less than 36 inches from granite complying with ASTM C 615.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Fletcher Granite Company, Inc.
 - b. Polycor Inc.
 - c. Swenson Granite Co.
 - 2. Granite Color and Grain: Light gray with fine grain.
 - 3. Total Height: 16 inches.
 - 4. Top Width: 5 inches.
 - 5. Top Finish: Sawed top surface, with no projections or depressions greater than 1/2-inch.
 - 6. Height top to bottom: 15" minimum.
 - 7. Face Height: 6 inches.
 - 8. Face Finish: Smooth quarry split with no projections greater than 3/4-inch or depression greater than 1/2-inch down to 2 inches below grade line. Vertical face at right angle to plane of top.
 - 9. Back: Parallel to face.
 - 10. Ends: Right angle to face, unless noted otherwise.
 - 11. Edges: "Buzzed Edge" at exposed edge at face of curb – 1/4" minimum.
 - 12. Curved Sections: Curb segments on curves with radii of 100 feet or less shaped to the required curvature, with the ends cut on radial lines.
 - 13. Special Shapes: As indicated.

14. Granite (stone) curb shall conform to NYSDOT Standard Specification 609 and Standard Sheet 609-01. Curb shall be the Top Width noted above and Type C. Exposure Height may vary.

2.2 MORTAR MATERIALS

- A. Portland Cement: ASTM C 150, Type I or Type II.
- B. Sand: ASTM C 144.
- C. Water: Potable.

2.3 MORTAR MIXES

- A. General: Comply with referenced standards and with manufacturers' written instructions for mix proportions, mixing equipment, mixer speeds, mixing containers, mixing times, and other procedures needed to produce joint materials of uniform quality and with optimum performance characteristics. Discard mortar if it has reached its initial set before being used.
 1. Mortar Proportion: Equal parts Portland cement and sand with sufficient water to make a workable mixture.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas indicated to receive stone curbing, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 INSTALLATION, GENERAL

- A. Do not use stone curbs with chips, cracks, voids, discolorations, or other defects that might be visible or cause staining in finished work.
- B. Cut stone curbs with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to fit adjoining work neatly. Use full units without cutting where possible.
- C. Tolerances: Do not exceed 1/8-inch unit-to-unit offset from flush and 1/4 inch in 10 feet from level, or indicated slope, for finished top surface of curbing.
- D. Expansion Joints: Provide for sealant-filled joints at locations and of widths indicated. Provide backing for sealant-filled joints. Sealant materials and installation are specified in Division 07 Section "Joint Sealants."
 1. Unless noted otherwise, provide expansion joints at 30 foot intervals.

- E. Install stone curb sections on continuous dry-mix concrete leveling bed, true to line and grade. Provide continuous concrete collar support.
- F. Fill joints with mortar (except at expansion joints), rodding in place, with the top and exposed face neatly pointed flush.
- G. Spaced Joint Widths: Provide 1/2-inch nominal joint width.

3.3 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace stone curbs that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.
- B. Cleaning: Remove excess mortar from exposed surfaces; wash and scrub clean.

END OF SECTION 32 16 40

SECTION 32 92 00 - TURF AND GRASSES**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Seeding.
 - 2. Hydroseeding.
 - 3. Turf planting soil.
 - 4. Turf planting soil amendments and fertilizers.
 - 5. Turf renovation.
 - 6. Turf
 - 7. Turf maintenance.

1.3 SUBMITTALS, GENERAL

- A. General: Submit all action submittals and informational submittals required by this Section concurrently.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated, including:
 - 1. Seed.
 - 2. Fertilizer.
 - 3. Compost.
 - 4. Imported Topsoil.

1.5 INFORMATIONAL SUBMITTALS

- A. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

B. Material Test Reports:

1. Imported Topsoil: Before delivery, submit written statement giving location of properties from which topsoil is to be obtained, names and addresses of property owners, analysis of topsoil, depth to be stripped, and any crops grown during the previous 5 years.
2. Compost: Before delivery, submit a recent US Composting Seal of Testing Assurance Program data sheet.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of turf during a calendar year. Submit before expiration of required initial maintenance periods.
- B. Warranty: Executed special warranty.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful turf establishment.
1. Turf Installer: Engage an experienced turf installation firm to perform work of this Section that has installed at least seven (7) acceptable projects of the type specified within past 5 years. Provide location and reference contacts for each of the submitted projects.
 2. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
 3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor with certifications outlined below on Project site when work is in progress.
 4. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the Professional Landcare Network:
 - a. Certified Turfgrass Professional, designated CTP.
 - b. Certified Turfgrass Professional of Cool Season Lawns, designated CTP-CSL.
- B. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; available nutrients; deleterious material; pH and recommendations to obtain optimal pH factor; mineral and plant-nutrient content of the soil; map with locations where each sample was collected; date, time and weather when samples were collected; and name of person who collected the samples.
1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.

2. The soil-testing laboratory shall oversee soil sampling, with depth, location, and number of samples to be taken per instructions from Architect. A minimum of three representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.
3. Report suitability of tested soil for turf growth.
 - a. Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1,000 sq. ft. or volume per cu. yd. for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
 - b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws, as applicable.
- B. Bulk Materials:
 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 3. Accompany each delivery of bulk fertilizers, lime, and soil amendments with appropriate certificates.

1.9 PROJECT CONDITIONS

- A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of planting completion.
 1. Spring Planting: March 15 to May 15.
 2. Fall Planting: August 15 to September 15.
- B. Hydroseeding Restrictions: Do not hydroseed without prior written permission of the Architect.

- C. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

1.10 SEQUENCING AND REVIEW

- A. Notify Architect no fewer than 72 hours in advance of proposed seeding to allow review of topsoil finish grading.
- B. Do not proceed with seeding without Architect's written permission.
 - 1. Architect's written permission does not alleviate Contractor from conforming to the required grades indicated on Drawings.

1.11 MAINTENANCE

- A. Initial Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable turf is established, as determined by the Architect, but for not less than the following periods:
 - 1. Seeded Turf: Five (5) documented mowings.
 - a. Document mowings in writing via fax or email to Owner and Architect on the day each mowing is performed. Failure of notification may subject Contractor to further mowings at no additional cost to Owner.
 - 2. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.
- B. Water: Provide all water required to properly irrigate temporary, permanent, and renovated turf areas. Include all facilities including, but not limited to, hoses, sprinklers, water cannons and reels, as long as it takes to establish and maintain turf. When adequate water supply or pressure is not available, supply water from offsite, including trucking.

1.12 WARRANTY

- A. Special Warranty: Installer agrees to repair or replace turf that fails in materials, workmanship, or growth within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner, or incidents that are beyond Contractor's control.

2. Warranty Period:
 - a. Turf: 12 months, after acceptable turf is established, as determined by the Architect.
3. Include the following remedial actions as a minimum:
 - a. Immediately remove dead turf and replace unless required to plant in the succeeding planting season.
 - b. Replace with seed as originally specified.
- B. Provide extended warranty for period equal to original warranty period, for replaced turf material.

PART 2 - PRODUCTS

2.1 SEED

- A. Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.
- B. Seed Blends: Seed blend with not less than 95 percent germination, not less than 85 percent live seed, and not more than 0.5 percent weed seed.
 1. If premixed blend, follow manufacturer's recommended maximum seeding rate unless otherwise noted.
- C. Lawn Seed:
 1. Varieties: Premier varieties of Kentucky bluegrass, perennial ryegrass, tall fescue and fine fescue with a mean ranking of 6.0 or higher on the National Turfgrass Evaluation Program (NTEP) current list of tested varieties for the Northeast United States.
- D. Seed Blends: Seed of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:
 1. General Lawn Mixture-Tall Fescue/Kentucky Bluegrass Blend: Proportioned by weight as follows:
 - a. 85 percent tall fescue (*Festuca arundinacea*).
 - b. 15 percent Kentucky bluegrass (*Poa pratensis*).
 2. General Lawn Mixture – Kentucky Bluegrass: Proportioned by weight as follows:
 - a. 85 percent 1/3 equal mixture of three Kentucky bluegrass (*Poa pratensis*) varieties.
 - b. 15 percent fine fescue (*Festuca rubra*).

3. General Lawn Sun/Shade Mixture: Proportioned by weight as follows:
 - a. 75 percent 1/3 equal mixture of three Kentucky bluegrass (*Poa pratensis*) varieties.
 - b. 25 percent fine fescue (*Fescue rubra*).
4. Athletic Field Blend (Kentucky bluegrass): Proportioned by weight as follows:
 - a. 90 percent 1/3 equal mixture of three Kentucky bluegrass (*Poa pratensis*) varieties.
 - b. 10 percent fine fescue (*Fescue rubra*).
5. Athletic Field Blend (Tall fescue/Kentucky Bluegrass): Proportioned by weight as follows:
 - a. 75 percent tall fescue.
 - b. 25 percent Kentucky Bluegrass
6. Conservation / Detention Basin Seed Blend: Provide native grass and forb seed mix containing the following varieties: *Panicum clandestinum* (Deertongue, “Tioga”); *Carex vulpinoidea* (Fox Sedge); *Elymus virginicus* (Virginia Wildrye); *Panicum virgatum* “Shawnee” (Switchgrass, “Shawnee”); *Agrostis perennans* (Autumn Bentgrass); *Agrostis scabra* (Rough Bentgrass); *Juncus effuses* (Soft Rush); *Juncus tenuis* (Path Rush); *Scirpus atrovirens* (Green Bulrush).
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide product manufactured by Ernst Conservation Seeds, Inc. “Native Detention Area Mix”, or comparable product.

2.2 INORGANIC SOIL AMENDMENTS

- A. Perlite: Horticultural perlite, soil amendment grade.
- B. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through No. 50 sieve.

2.3 ORGANIC COMPOST

- A. Compost: Organic product manufactured through the controlled aerobic, biological decomposition of biodegradable materials which involves mesophilic and thermophilic temperatures to reduce weed seeds and stabilize carbon content. Manufacturing facility is to be registered and/or permitted by New York State Department of Environmental Conservation and is to comply with their requirements.

B. Compost requirements:

Parameters	Units of Measure	Range	Analysis Method
pH	pH units	5.8-7.8	TMECC 04.11-A
Soluble Salts Concentration (electrical conductivity)	dS/m (mmhos/cm)	Maximum 6	TMECC 04.10-A
Moisture Content	%, wet weight basis	20-50	TMECC 03.09-A
Organic Matter Content	%, dry weight basis	Minimum 60	TMECC 05.07-A
Particle Size	% passing a selected mesh size, dry weight basis	97-100% Passing 3/8"	TMECC 02.02-B or ASTM D 2977
C:N Ratio	Ratio, dry weight basis	5:1 – 30:1	TMECC 05.02-A
Physical Contaminants (man-made inerts)	%, dry weight basis	<.50	TMECC 03.08

- C. Mix with existing and imported topsoils in ratio designated in “Turf Planting Soil” Article below. Compost must be provided for both existing and imported topsoil, with the exception of topsoil with 10% of organic content and above.
- D. Compost testing is to be in accordance with the US Composting Seal of Testing Assurance Program.
- E. Basis-of-Design Product: Subject to compliance with requirements, provide one of the following or a comparable product:
1. Naturcycle Compost, Naturcycle LLC
 2. WeCare Compost, WeCare Organics
 3. Sustane Concentrated Compost 2-6-3, Sustane Natural Fertilizer, Inc.
 4. Agresource, Inc. - Agresoil Compost

2.4 FERTILIZERS

- A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 4 percent nitrogen and 20 percent phosphoric acid.
- B. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition, unless otherwise indicated:

1. Spring Fertilization: 10 percent nitrogen, 6 percent available phosphorous, and 4 percent water-soluble potash (10-6-4).
2. Fall Fertilization: 5 percent nitrogen, 10 percent available phosphorous, and 5 percent water-soluble potash (5-10-5).
3. Final Fertilization:
 - a. Spring: Granular slow release fertilizer with high nitrogen (38 percent), Uramite or other Architect-approved material.
 - b. Fall: "Fall Fertilization" composition above.
4. Follow requirements regarding fertilization recommended in soil reports from a qualified soil-testing laboratory.

2.5 TURF PLANTING SOILS

- A. General: Provide turf planting soil consisting of existing and/or imported topsoil with amendments and fertilizers noted in this Section. Unamended existing or imported topsoil is not acceptable as turf planting soil.
 1. Where quantities of existing topsoil are insufficient to provide 6 inch depth turf planting soil, supplement with imported topsoil, at no additional cost to Owner.
- B. Topsoil Requirements: Free of subsoil, stones 1 inch or larger in any dimension, dense material, hardpan, slag, clay, cinders, sod, roots, sticks, poison ivy, crabgrass, cough grass, noxious weeds, and foreign matter, including but not limited to glass, screws, asbestos, toxins, hazardous wastes, petroleum product contamination, lead and chemicals (such as atrizene and muriatic acid) that may be injurious to humans, animals and plant materials.
 1. Mechanically screen topsoil to conform to following gradations:

<u>Sieve Designation</u>	<u>Percent Passing</u>
1 inch.....	100
1/4 inch.....	97-100
#200.....	20-65 of the 1/4-inch sieve
 2. No more than 60 percent of material passing #100 mesh shall consist of clay as determined by Bouyoucous hydrometer or by decantation method.
 3. Topsoil to comply with the following:
 - a. Organic Matter Content: Not more than 10 percent.
 - b. Corrected to pH Value: 6.5 to 7.5 on that portion passing 1/4-inch sieve.
 - c. Soluble Salt Content: Not to exceed 500 parts per million.
- C. Existing Topsoil: Existing, native surface topsoil formed under natural conditions with the duff layer retained during excavation process and stockpiled on-site. Verify suitability of native surface topsoil to produce viable planting soil.
 1. Provide soil analysis per requirements in Part 1 of this Section.

- D. Imported Topsoil: Imported topsoil obtained from local sources or from areas having similar soil characteristics as Project site. Obtain topsoil displaced from naturally well-drained sites where topsoil occurs at least 6 inches deep; do not obtain from agricultural land, bogs or marshes.
1. Additional Properties of Imported Topsoil or Manufactured Topsoil: Screened and free of stones 1 inch or larger in any dimension; free of roots, plants, sod, clods, clay lumps, pockets of coarse sand, paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials harmful to plant growth; free of obnoxious weeds and invasive plants including quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and brome grass; not infested with nematodes, grubs, other pests, pest eggs, or other undesirable organisms and disease-causing plant pathogens; friable and with sufficient structure to give good tilth and aeration. Continuous, air-filled, pore-space content on a volume/volume basis shall be at least 15 percent when moisture is present at field capacity. Soil shall have a field capacity of at least 15 percent on a dry weight basis.
 2. Provide soil analysis per requirements in Part 1 of this Section.
- E. Required Amendments: Mix existing and imported topsoil with the following soil amendments in the following quantities to produce planting soil:
1. Organic Compost:
 - a. Ratio of Loose Compost to Blended Topsoil: For bidding purposes, provide 1 part compost to 5 parts blended topsoil. This amount of compost is required regardless of organic content of native or imported topsoil.
 - b. Regardless of topsoil organic content, add organic compost to all turf planting soils, including topsoils placed on slopes and in stormwater basins, swales and biofiltration areas.
 2. pH Adjustment: Apply approved calcium or sulfur compounds to correct pH level to be between 6.5 and 7.5 or as recommended by soil analysis report.
 3. Soil Analysis Recommendations: Provide nutritional and other amendments recommended in the soil analysis report, as approved by Architect.
 4. Provide fertilizer per "Fertilizer" Article above.

2.6 TOPDRESSING SAND

- A. Provide processed sand tested to meet the following requirements per ASTM-F-1632.

- B. Processed Sand: The sand shall meet the following particle size criteria:

	Sieve Mesh	Diameter of Sieve (mm)	Allowable Range % retained
Coarse Gravel	5	4.00	0%
Fine Gravel	10	2.00	0-5%
Very Coarse Sand	18	1.00	0-20% combined with gravel
Coarse	35	0.50	20-50%
Medium	60	0.25	20-40%
Fine	100	0.15	20% maximum
Very Fine	270	0.075	5% maximum
Silt & Clay			3% maximum

1. Sand is to have a coefficient of uniformity not exceeding 3.5 (D60/D10).
2. Maximum of 5% combined very fine sand, silt and clay allowable.
3. Minimum of 60% in the medium and coarse size fractions required.

- C. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

2.7 HYDROSEEDING MATERIALS

- A. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.
- B. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

2.8 EROSION-CONTROL MATERIALS

- A. Refer to Section 31 25 00 "Erosion and Sedimentation Controls."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.
 - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
 - 2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
 - 3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
 - 4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.
- D. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
 - 1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
 - 2. Protect grade stakes set by others until directed to remove them.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 TURF AREA PREPARATION

- A. Limit turf subgrade preparation to areas to be planted.
- B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 4 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
- C. Bulk-mix screened topsoil, soil amendments, organic compost and fertilizer, and thoroughly blend planting soil.

1. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
 2. If soil testing recommendations do not provide fertilizer application quantities, provide application rate of 1 lb. of nitrogen per 1,000 square feet.
 3. If liming is required, mix lime with dry soil before mixing fertilizer.
- D. If topsoil is to remain in place, thoroughly incorporate the additives into the top 6 inches of topsoil.
- E. Spread planting soil to a depth of 6 inches but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
1. Spread approximately 1/3 the thickness of planting soil over loosened subgrade. Mix thoroughly into top 2 inches of subgrade. Spread remainder of planting soil.
- F. Unchanged Subgrades: If topsoil is to remain in place, prepare surface soil as follows:
1. Cut neat line between existing turf to remain and new turf.
 2. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
 3. Loosen surface soil to a depth of at least 6 inches. Uniformly apply the soil amendments, organic compost and fertilizer over the entire area using a compost spreader or similar equipment that will achieve a uniform application, according to planting soil mix proportions and mix thoroughly into top 5 inches of soil. Till soil to a homogeneous mixture of fine texture.
 - a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
 4. Remove stones larger than 1 inch in any dimension and sticks, roots, trash, and other extraneous matter.
 5. Legally dispose of waste material, including grass, vegetation, and turf.
- G. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.
- H. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- I. Before planting, obtain Architect's written permission; restore planting areas if topsoil finish grading is eroded or otherwise disturbed after finish grading.

3.4 PREPARATION FOR EROSION-CONTROL MATERIALS

- A. Erosion Control Matting: Install amended topsoil and seed before erosion control matting is installed. Follow manufacturer's installation recommendations.

3.5 SEEDING

- A. Timing: Provide seeding within planting times indicated.
 - 1. Seed at earliest possible date to achieve mature turf prior to Owner occupancy.
 - 2. Sow Tall Fescue varieties preferably in fall.
- B. Sow seed with Brillion spreader or similar seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in three passes: second pass at 90 degrees to the first, third pass at 45 degrees to second.
 - 1. Do not use wet seed or seed that is moldy or otherwise damaged.
 - 2. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.
- C. Sow seed at a total rate of 6 lb/1,000 sq. ft.
- D. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.
- E. Protect seeded areas with slopes not exceeding 1:4 as follows:
 - 1. In small areas adjacent to buildings, at parking islands and narrow strips of seeding along paving, spread straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment. Avoid areas of thick mulch that will prevent seed determination.
 - 2. In larger areas, including athletic fields if approved by Architect, mulch by hydromulching.
- F. Water newly planted areas and keep moist until new turf is established.

3.6 HYDROSEEDING

- A. Prior Permission: Request permission of Architect for hydroseeding. Do not hydroseed without prior written permission of the Architect. Equipment and materials must be submitted and approved before permission to hydroseed will be given.
- B. Hydroseeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.
 - 1. Mix slurry with fiber-mulch manufacturer's recommended tackifier.
 - 2. Apply slurry uniformly to all areas to be seeded in a **two-step process**.
 - a. Apply first slurry coat containing mulch and seed at a rate so that mulch component is deposited at not less than 500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate.

- b. Apply slurry cover coat of fiber mulch (hydromulching) at a rate of 1,000 lb/acre. For slopes greater than 10 percent, apply second coat at 1,500 lb/acre.
 - 3. When hydromulching, avoid overspray on buildings, pavements, signs and other site features. If overspray occurs, clean mulch from all surfaces.
- C. Water newly planted areas and keep moist until new turf is established.
- D. Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
 - 1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
 - 2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
 - 3. Use hand weeding to control weeds. Schedule weedings throughout the year to maintain turf as free of weeds as possible.
- E. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.
 - 1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
 - 2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.
- F. Mow turf when new growth reaches 3.75-4.5 inches in height. Repeat mowing to maintain specified height once per week or as needed to ensure the maximum height does not exceed 4.5 inches between mowing. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:
 - 1. Mow turf to a height of 2-1/2 to 3 inches.
 - 2. Neatly trim edges and hand clip where necessary.
 - 3. Immediately after each mowing (same day), carefully remove excess clippings to prevent damage to turf.
- G. Turf Postfertilization: Apply fertilizer after initial mowing and when grass is dry.

3.7 SATISFACTORY TURF

- A. Turf installations shall meet the following criteria as determined by Architect:
 - 1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.

- B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.
- C. Warranty period does not begin until satisfactory turf is established, as determined by the Architect.

3.8 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.
- C. Remove nondegradable erosion-control measures after grass establishment period.

END OF SECTION 32 92 00

SECTION 33 41 00 - STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Pipe and fittings.
2. Non-pressure transition couplings.
3. Pressure pipe couplings.
4. Perforated Edge Drains.
5. Cleanouts.
6. Drains.
7. Frames and grates/lids
8. Channel drainage systems.
9. Catch basins.
10. Stormwater Manholes.
11. Dry wells.
12. Stormwater Outlet structures.
13. Pipe outlets.
14. Stormwater disposal systems.
15. Flared End Sections

B. Related Sections:

1. Section 01 78 39 "Project Record Documents"
2. Section 31 20 00 "Earth Moving"

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings:

1. Stormwater Manholes: Include plans, elevations, sections, details, frames, covers, and grates.
2. Catch basins. Include plans, elevations, sections, details, frames, covers, and grates.
3. Dry wells. Include plans, elevations, sections, details, frames, covers, and grates.

- C. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from storm drainage system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements: Perform work, including shoring, in compliance with the applicable requirements of governing authorities having jurisdiction.
 - 1. Install connections to municipal sewer in accordance with local sewer authority standards and OSHA regulations. Provide materials complying with local sewer authority standards.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic manholes, pipe, and fittings in direct sunlight.
- B. Protect pipe, pipe fittings, and seals from dirt and damage.
- C. Handle stormwater manholes according to manufacturer's written rigging instructions.
- D. Handle catch basins according to manufacturer's written rigging instructions.

1.6 PROJECT CONDITIONS

- A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1. Notify Owner no fewer than two days in advance of proposed interruption of service.
 - 2. Do not proceed with interruption of service without Owner's written permission.

PART 2 - PRODUCTS

2.1 SOLID DOUBLE WALL HDPE SMOOTH INTERIOR PIPE:

- A. Interior Diameter, 4" to 36": Corrugated polyethylene circular pipe with an integrally formed smooth interior complying with the following specifications:
 - 1. Applicable Standards:
 - a. 4 inch to 10 inch pipe: AASHTO M 252-Type S or SP
 - b. 12 inch to 36 inch pipe: AASHTO M294-Type S or SP
 - 2. Mannings "n" Value: 0.012.
 - 3. ASTM D3034 for maximum allowable deflection.

4. Fittings: Meet performance requirements of ASTM D 3034 and ASTM F 1336. Gaskets to comply with ASTM F477.
 5. Manufacturer: Similar to "N-12 Smooth Interior Pipe" by Advanced Drainage Systems, Inc.; London, Ohio.
- B. Interior Diameter, 42" to 60": Corrugated polyethylene circular pipe with an integrally formed smooth interior complying with the following specifications:
1. Applicable Standards
 - a. 42 inch to 48 inch pipe: AASHTO MP6
 - b. 60 inch pipe: AASHTO MP7
 2. Mannings "n" Value: 0.012.
 3. ASTM D3034 for maximum allowable deflection.
 4. Fittings to meet performance requirements of ASTM D 3034 and ASTM F 1336. Gaskets to comply with ASTM F477.
 5. Manufacturer: Similar to "N-12 HC High Capacity Large Diameter Pipe" by Advanced Drainage Systems, Inc.; London, Ohio.
- C. Interior Diameter, 4" to 30": Corrugated polyethylene circular pipe with silt-tight joints and an integrally formed smooth interior complying with the following specifications:
1. Applicable Standards
 - a. 4 inch to 10 inch pipe: AASHTO M 252-Type S or SP
 - b. 12 inch to 36 inch pipe: AASHTO M 294-Type S or SP
 2. Mannings "n" Value: 0.010.
 3. Fittings: AASHTO M252 or M294.
 4. Joints: Meeting AASHTO Standard Specification for Highway Bridges, Section 26 paragraph 26.4.2.4(e). Silt tight – meeting ASTM D1056 Grade 2A2.
 5. Materials: ASTM 3350 minimum cell classification 324420C (4" to 10") or 335420C (12" to 30").
 6. Similar to "Hi-Q Pipe" by Hancor, Inc.; Findlay, Ohio.
- D. Interior Diameter, 36" to 60": Corrugated polyethylene circular pipe with an integrally formed smooth interior complying with the following specifications:
1. Applicable Standard: AASHTO M 294-Type S or SP
 2. Mannings "n" Value: .010.
 3. Fittings: AASHTO M294.
 4. Joints: "Sure-Lok" joints meeting AASHTO M294.

5. Materials: ASTM 3350 minimum cell classification 335420C.
6. Similar to “Sure-Lok F477 Pipe” by Hancor, Inc.; Findlay, Ohio.

2.2 PERFORATED SINGLE WALL HDPE CORRUGATED PIPE:

- A. Interior Diameter, 3" to 24": Corrugated perforated single wall polyethylene circular pipe with uniform slots and drilled holes complying with the following specifications:
 1. Applicable Standards:
 - a. 3 inch to 10 inch pipe: AASHTO M 252
 - b. 12 inch to 24 inch pipe: AASHTO M294
 2. Fittings: Meet performance requirements of ASTM D 3034 and ASTM F 1336. Gaskets to comply with ASTM F477.
 3. Manufacturer: Similar to “Perforated Single Wall Plastic Corrugated Pipe” by Advanced Drainage Systems, Inc.; London, Ohio.

2.3 PVC PIPE AND FITTINGS

- A. PVC Gravity Sewer Piping:
 1. Pipe: ASTM D 3034, SDR 35 PVC Type PSM sewer pipe, green in color, with bell-and-spigot ends for gasketed joints.
 2. Fittings: ASTM D 3034, PVC with bell ends.
 3. Gaskets: ASTM F 477, elastomeric seals.
- B. PVC Pressure Piping:
 1. Pipe: AWWA C900, Class 200 PVC pipe with bell-and-spigot ends for gasketed joints.
 2. Fittings: AWWA C900, Class 200 PVC pipe with bell ends
 3. Gaskets: ASTM F 477, elastomeric seals.
- C. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Charlotte Pipe and Foundry
 2. J-M Manufacturing
 3. IPEX Inc.

2.4 NONPRESSURE TRANSITION COUPLINGS

- A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:

1. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
2. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
3. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

C. Unshielded, Flexible Couplings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Dallas Specialty & Mfg. Co.
 - b. Fernco Inc.
 - c. Mission Rubber Company; a division of MCP Industries, Inc.
 - d. NDS Inc.
 - e. Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
2. Description: Elastomeric sleeve with corrosion-resistant-metal tension band and tightening mechanism on each end.

2.5 PRESSURE PIPE COUPLINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Cascade Waterworks Mfg.
 2. Dresser, Inc.
 3. Ford Meter Box Company, Inc. (The); Pipe Products Div.
- B. Description: AWWA C219, tubular-sleeve coupling, with center sleeve, gaskets, end rings, and bolt fasteners.
- C. Metal, bolted, sleeve-type, reducing or transition coupling, for joining underground pressure piping. Include 200-psig minimum pressure rating and ends sized to fit adjoining pipes.
- D. Center-Sleeve Material: Manufacturer's standard.
- E. Gasket Material: Natural or synthetic rubber.
- F. Metal Component Finish: Corrosion-resistant coating or material.

2.6 PERFORATED EDGE DRAINS

- A. Perforated Edge Drain Piping: 1" x 12" polyethylene multi-channeled edge drain with polypropylene filter fabric sock. Provide all fittings and connections required for installation fabricated by manufacturer of drainage piping used. Similar to "AdvanEdge Pipe" by Advanced Drainage Systems.

1. Pipe Properties

- a. Compressive Strength (ASTM D-695):..... 6,000 psf (41.7 psi) minimum.
- b. Flow Rate (ASTM D-4716): 11gpm/sf.
- c. Peel Strength (ASTM D-1876):..... 35 lbs/ft minimum.
- d. Core Thickness: 0.80"

2. Drainage Fabric Properties

- a. Grab Tensile Strength (D-4632): 120 lbs.
- b. Grab Elongation Strength (ASTM D-4632):... 60%.
- c. Mullen Burst Strength (ASTM 3786): 90 psi.
- d. Puncture Strength (ASTM 4833): 30 lbs.
- e. Trapezoid Tear Strength (ASTM D-4533): 40 lbs.
- f. U.V. Resistance (ASTM D-4355): 70% strength retained.
- g. A.O.S.: Per ASTM D-4751
- h. Permeability (ASTM 4491): K Fabric > K Soil
- i. Permittivity (ASTM 4491): 7

2.7 CORRUGATED STEEL PIPE AND FITTINGS

A. Corrugated-Steel Pipe and Fittings: ASTM A 760, Type I with fittings of similar form and construction as pipe.

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Contech.
- 2. Galvanized, fully bituminous-coated round corrugated steel pipe complying with New York State Department of Transportation Standard Specification Section 707-02 and AASHTO M190, Type I.
- 3. Unless otherwise noted, provide the following gauge of pipe:
 - a. 24" or less diameter: 16 gauge.
 - b. 30" to 36" diameter: 14 gauge.
- 4. Construct joints with corrugated bands lapping equal portions of each pipe section to be connected and fabricated to allow firm and secure field connection.
- 5. Special Joint Bands: Corrugated steel with O-ring seals.
- 6. Standard Joint Bands: Corrugated steel.
- 7. Coating: Aluminum.
- 8. Special-Joint Bands: Corrugated steel with O-ring seals.

2.8 CLEANOUTS

A. Cast-Iron Cleanouts:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Josam Company.
 - b. Smith, Jay R. Mfg. Co.
 - c. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.
2. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover with vandal proof screws. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
3. Top-Loading Classification(s): Heavy Duty.
4. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

B. Plastic Cleanouts:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. NDS Inc.
 - b. Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
 - c. Zurn Light Commercial Products Operation; Zurn Plumbing Products Group.
2. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.9 DRAINS

A. Inline Drains:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Nyloplast by Advance Drainage Systems, Inc.
2. Description: Precast PVC Inlet with cast or ductile iron body with anchor flange and round grate in diameter shown on Drawings. Include watertight pipe adapters of sizes indicated.
 - a. Joint tightness shall conform to ASTM D3212 for joints for drain and sewer plastic pipe using flexible elastomeric seals

- b. Metal used in the manufacture of the castings shall conform to ASTM A536 grade 70-50-05 for ductile iron and ASTM A-48-83 class 30B for 12" and 15" cast iron frames. Grates shall be provided painted black
- 3. Backfill Material
 - a. The backfill material shall be crushed stone or other granular material meeting the requirements of Structure Bedding as defined in Section 31 20 00 Earth Moving.
 - b. The drainage inlets shall be bedded and back-filled uniformly in accordance with ASTM D2321.
- 4. Top-Loading Classification(s): Heavy Duty H20 Traffic Loading.

2.10 FLARED END SECTIONS

- A. Galvanized Steel End Sections: Flared end sections manufactured in accordance with New York State Department of Transportation Standard Specification, Item 707-10.

2.11 CONCRETE

- A. General: Cast-in-place concrete according to ACI 318, ACI 350/350R, and the following:
 - 1. Cement: ASTM C 150, Type II.
 - 2. Fine Aggregate: ASTM C 33, sand.
 - 3. Coarse Aggregate: ASTM C 33, crushed gravel.
 - 4. Water: Potable.
- B. Portland Cement Design Mix: 4,000 psi minimum, with 0.45 maximum water/cementitious materials ratio.
 - 1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
 - 2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.
- C. Ballast and Pipe Supports: Portland cement design mix, 3,000 psi minimum, with 0.58 maximum water/cementitious materials ratio.
 - 1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
 - 2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

2.12 CHANNEL DRAINAGE SYSTEMS

- A. Channel Drain System "4-in WIDE WAVE GRATE"
 - 1. General Requirements Channel Drainage Systems: Modular system of precast, polymer-concrete channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling. Include quantity of units required to form total lengths indicated.

2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work. Equivalent to “KS100 KlassikDrain” by ACO Polymer Products, Inc. in Chardon, Ohio. Telephone: (800)543-4764 Web: www.acousa.com; or equal:
 - a. ABT, Inc.
 - b. Poly-Cast.
3. Sloped-Invert, Polymer-Concrete Systems:
 - a. Trench Drain Channel Sections:
 - 1) Compressive Strength: 14,000 P.S.I.
 - 2) Flexural Strength: 4,000 P.S.I.
 - 3) Water Absorption Rate: 0.07%
 - 4) Edge Rail: Stainless Steel
 - 5) Edge Rail thickness: 3/32-in min.
 - 6) Wall thickness: 0.50-in min.
 - 7) Internal slope: 0.5%
 - 8) Unit Width: 5.12-in
 - 9) Internal Width: 4.00-in
 - 10) Unit invert depth: (Varies) 4.13-in to 11.81-in
 - 11) Unit length: 39.37-in (1-Meter)
 - 12) Partial radius trench bottom.
 - 13) Interlocking-joint, precast, modular units with end caps.
 - b. Trench Drain Grates “4-in WIDE WAVE GRATE”:
 - 1) Resin composite grate, equivalent to “ACO Type 480D Iron Wave” grate by ACO Polymer Products, Inc. in Chardon, Ohio. Telephone: (800)543-4764 Web: www.acousa.com
 - 2) Certified to EN 1433 Load Class C (56,000 lbs – 1,162 psi)
 - 3) Material: Ductile iron to ASTM A 536-84, Grade 65-45-12
 - 4) Size: 4.84-in Width by 19.69-in Length each unit.
 - 5) Slots to measure at 0.27-in by 2.4-in.
 - 6) “DrainLok” or equivalent boltless locking system
 - 7) Intake area of 27.0 sq. in per half meter of grate
 - 8) E-Coated for improved rust resistance
 - 9) Complies with ADA – American Disability Act of 1990 Section 4.5.4
 - 10) Bicycle Tire Penetration Resistance to AS 3996-2006.

4. Drainage Specialties: Precast, polymer-concrete units.
 - a. Catch Basins:
 - 1) To suite KS100 Channel Drain
 - 2) Type “K1-901S” In-Line Catch Basin
 - 3) 19.69-in to 22.67-in by approximately 10.06-in polymer-concrete body, with outlets in quantities and sizes indicated.
 - 4) Grate: ACO Type 480D Iron Wave.
5. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.
6. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

2.13 CHANNEL DRAINAGE SYSTEMS

A. Channel Drainage Systems “8-in WIDE WAVE GRATE”

1. Trench Drain (Sloped-Invert, Polymer–Concrete System): Precast polyester or vinyl ester resin, interlocking channel unit, with built-in 0.5% slope and recesses for lock down devices, and stainless steel edge rail. Equivalent to “KS200 KlassikDrain” by ACO Polymer Products, Inc. in Chardon, Ohio. Telephone: (800)543-4764 Web: www.acousa.com
 - a. Trench drain channel:
 - 1) Compressive Strength: 14,000 P.S.I.
 - 2) Flexural Strength: 4,000 P.S.I.
 - 3) Water Absorption Rate: 0.07%
 - 4) Edge Rail thickness: 3/32-in min.
 - 5) Wall thickness: 0.50-in min.
 - 6) Internal slope: 0.5%
 - 7) Unit Width: 10.24-in
 - 8) Internal Width: 8.00-in
 - 9) Unit invert depth: (Varies) 7.87-in to 15.75-in
 - 10) Unit length: 39.37-in (1-Meter)
 - 11) Full radius trench bottom.
 - 12) Frost proof, salt proof, dilute acid and alkali resistant.
 - b. Trench drain catch basins: Equivalent to ACO “K2-621S” precast polymer concrete catch basin, with integral plastic PVC trash bucket with removable grating.
 - 1) Compressive Strength: 14,000 P.S.I.
 - 2) Flexural Strength: 4,000 P.S.I.
 - 3) Material: Cast in stainless steel frame with polyester polymer concrete top unit body
 - 4) Water Absorption Rate: 0.07% by weight

- 5) Edge Rail thickness: 1/8-in min.
 - 6) Wall thickness: 0.59-in min.
 - 7) Unit Width: 14.25-in
 - 8) Unit Depth: 37.64-in
 - 9) Unit length: 19.69-in (0.5-Meter)
 - 10) Frost proof, salt proof, dilute acid and alkali resistant.
- c. Trench drain grates: Resin composite grate, equivalent to “ACO Type 680Q Iron Wave” grate by ACO Polymer Products, Inc. in Chardon, Ohio. Telephone: (800)543-4764 Web: www.acousa.com
- 1) Independently certified to meet Load Class C to EN 1433 – 56,000 lbs – 1,162 psi
 - 2) Material: Ductile iron to ASTM A 536-84, Grade 65-45-12
 - 3) Size: 9.41-in Width by 19.69-in Length each unit, 1.18-in thick. Slots to measure at a maximum of 0.43-in.
 - 4) “QuickLok” or equivalent boltless locking system
 - 5) Intake area of 58.72 sq. in per half meter of grate
 - 6) E-Coated for improved rust resistance
 - 7) AMA – American Disabilities Act of 1990 Section 4.5.4 Compliance
 - 8) Bicycle tire penetration resistance to AS 3996-2006

2.14 CHANNEL DRAINAGE SYSTEMS

- A. General Requirements Channel Drainage Systems: Modular system of precast, polymer-concrete channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling. Include quantity of units required to form total lengths indicated.
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. ABT, Inc.
 2. ACO USA.
 3. Poly-Cast.
- C. Sloped-Invert, Polymer-Concrete Systems:
1. Channel Sections:
 - a. Interlocking-joint, precast, modular units with end caps.
 - b. 4-inch inside width and deep, rounded bottom, with built-in invert slope of 0.6 percent and with outlets in quantities, sizes, and locations indicated.
 - c. Extension sections necessary for required depth.
 - d. Frame: Include gray-iron or steel frame for grate.
 2. Grates:
 - a. Manufacturer's designation "Heavy Duty," with slots or perforations that fit recesses in channels.

- b. Material: Gray iron.
 - c. Grating must meet ADA requirements in Pedestrian areas.
- 3. Covers: Solid gray iron if indicated.
- 4. Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.
- D. Drainage Specialties: Precast, polymer-concrete units.
 - 1. Catch Basins:
 - a. 19-inch to 24-inch by approximately 6-inch polymer-concrete body, with outlets in quantities and sizes indicated.
 - b. Gray-iron slotted grate.
 - c. Frame: Include gray-iron or steel frame for grate.
- E. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.
- F. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

2.15 STORMWATER INLETS

- A. Curb Inlets: Made with vertical curb opening.
- B. Gutter Inlets: Made with horizontal gutter opening. Include heavy-duty frames and grates.
- C. Combination Inlets: Made with vertical curb and horizontal gutter openings. Include heavy-duty frames and grates.

2.16 CATCH BASINS

- A. Inside Dimension: 30-inch by 30 inch clear inside area, unless otherwise indicated.
- B. Description: ASTM C 913, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
- C. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
- D. Riser Sections: 4-inch minimum thickness, Length, Width and Depth as indicated.
- E. Top Section: Flat-slab-top type is indicated.
- F. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
- G. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.
- H. Grade Rings: Include two or three reinforced-concrete rings, of 6 to 9-inch total thickness, that match the frame and grate, and height as required to adjust manhole frame and cover to indicated elevation and slope.

- I. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.

2.17 CATCH BASIN FRAMES AND GRATES

A. Heavy Duty Ductile Iron Frame and Grate:

1. Description: Heavy-duty 24-in by 24-in (nominal clear opening) ductile iron frame and grate.
2. Material Requirements:
 - a. Material: ASTM A 536, Grade 70-50-05, ductile iron designed for A-16, structural loading. Meets AASHTO M306
 - b. Grate style: Bar, Flat
 - c. Frame style: Top Flange, Reversible, Bottom Flange
 - d. Coating: Asphaltic Coated
 - e. Color: Black
 - f. Origin of manufacture: USA
 - g. Clear opening depth: 24-in minimum, unless otherwise indicated
 - h. Clear opening length: 24-in minimum, unless otherwise indicated
 - i. Cover/Grate opening depth: 2-in
 - j. Cover/Grate opening width: 26-in
 - k. Cover/Grate opening length: 26in
 - l. Flange inner length: 26-in
 - m. Flange inner width: 26-in
 - n. Flange outer length: 32-in
 - o. Flange outer width: 32-in
 - p. Frame height: 6-in
 - q. Frame outside length: 27.5-in
 - r. Frame outside width: 27.5-in
 - s. Grate thickness: 2-in
 - t. Grate length: 25.75-in
 - u. Grate width: 27.75-in
 - v. Grate open area: 321 sq. in.
 - w. Grate wetted perimeter: 103-in
 - x. Slot width: 1.5-in
 - y. Tag Text: "Drains To Waterways Dump No Waste!"
3. Basis-of-Design Product: Subject to compliance with requirements, provide EJ Group Inc., Product No. 45726033C03 – "Classic Series V5626-2 REV 6" V5726 EXHD DI GR SET" by EJ Group Inc. (East Jordan Iron Works), 301 Spring Street, East Jordan, MI 49727 Telephone: 1-800-874-4100.

B. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for A-16, structural loading. Include flat grate with small square or short-slotted drainage openings.

1. Size: 24-in by 24-in minimum unless otherwise indicated.
2. Grate Free Area: Approximately 50 percent unless otherwise indicated.

- C. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for A-16, structural loading. Include 24-inch ID by 7 to 9-inch riser with 4-inch minimum width flange, and 26-inch- diameter flat grate with small square or short-slotted drainage openings.

1. Grate Free Area: Approximately 50 percent unless otherwise indicated.

2.18 DRY WELLS

- A. Description: ASTM C 913, precast, reinforced, perforated concrete rings. Include the following:

1. Floor: Cast-in-place concrete.
2. Cover: Liftoff-type concrete cover with cast-in lift rings.
3. Wall Thickness: 4 inches minimum with 1-inch diameter or 1-by-3-inch- maximum slotted perforations arranged in rows parallel to axis of ring.
 - a. Total Free Area of Perforations: Approximately 15 percent of ring interior surface.
 - b. Ring Construction: Designed to be self-aligning.
4. Filtering Material: ASTM D 448, Size No. 24, 3/4- to 2-1/2-inch washed, crushed stone or gravel.

2.19 STORMWATER MANHOLE

- A. Standard Precast Concrete Stormwater Manholes:

1. Diameter: 48 inches minimum unless otherwise indicated.
2. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
3. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
4. Riser Sections: 4-inch minimum thickness, 48-inch diameter, and lengths to provide depth indicated.
5. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
6. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
7. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.

8. Grade Rings: Include two or three reinforced-concrete rings, of 6 to 9-inch total thickness, that match 24-inch diameter frame and grate, and height as required to adjust manhole frame and cover to indicated elevation and slope.
9. Steps: Individual FRP steps; FRP ladder; or ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of catch basin to finished grade is less than 48 inches.
10. Ballast: Increase thickness of precast concrete sections or add concrete to base section as required to prevent flotation.
11. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.

2.20 STORMWATER MANHOLES / DRYWELL – FRAMES AND GRATES / COVERS

A. Frames and Grates (Open Grates):

1. Description: Castings of uniform quality, free from blow holes, porosity, hard spots, shrinkage defects, cracks, or other injurious defects. Manufactured true to pattern and free from surface imperfections. Provide machined horizontal bearing surfaces on heavy duty round frames and grates and fabricate round frames and grates in pavement of non-rocking design or with machined bearing surfaces. Grinds finish other units to proper fit.
2. Frame and Grate
 - a. Material: Class 35B Cast Iron
 - b. Loading Requirements: AASHTO M306 (Meets or Exceeds H20 Loading)
 - c. Coating: Shop Dipped Black Asphaltum.
3. Frame:
 - a. Frame Depth: 7-inches
 - b. Clear open width: 24 inches
 - c. Overall frame width: 36 inches diameter
4. Grate – Non-ADA Flat Grate:
 - a. 26 inch open diameter
 - b. Grate Open Area: 190 square inches
 - c. Lettering: “Dump No Waste”
5. Grate – ADA Flat Grate:
 - a. 26 inch open diameter
 - b. Grate Open Area: 130 square inches
 - c. Lettering: “Dump No Waste”

6. Basis of Design: Similar to Frame “Model #1045 (#00104510) and Grate “Type M3 ADA Grate” (#00104036) by East Jordan Iron Works, Inc.
7. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Neenah Foundry Co.
 - b. East Jordan Iron Works, Inc (EJ Group, Inc.)
 - c. Campbell Foundry
 - d. General Foundries

B. Frames and Covers (Solid Cover):

1. Description: Castings of uniform quality, free from blow holes, porosity, hard spots, shrinkage defects, cracks, or other injurious defects. Manufactured true to pattern and free from surface imperfections. Provide machined horizontal bearing surfaces on heavy duty round frames and covers and fabricate round frames and covers in pavement of non-rocking design or with machined bearing surfaces. Grinds finish other units to proper fit. Apply shop coat of asphaltum to all units.
2. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."
3. Material: Heavy Duty Round Frame and Covers, weight at least 350 lbs, meeting ASTM A 48/A 48M, Class 35 gray iron unless otherwise indicated.
4. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Neenah Foundry Co.
 - b. East Jordan Iron Works, Inc (EJ Group, Inc.)
 - c. Campbell Foundry
 - d. General Foundries

2.21 STORMWATER TREATMENT DEVICES

A. Materials and Design

1. Precast concrete components shall conform to applicable sections of ASTM C 478, ASTM C 857 and ASTM C 858 and the following:
 - a. Concrete shall achieve a minimum 28-day compressive strength of 4,000 pounds per square-inch (psi);
 - b. Unless otherwise noted, the precast concrete sections shall be designed to withstand lateral earth and AASHTO H-20 traffic loads;
 - c. Cement shall be Type III Portland Cement conforming to ASTM C 150;

- d. Aggregates shall conform to ASTM C 33;
 - e. Reinforcing steel shall be deformed billet-steel bars, welded steel wire or deformed welded steel wire conforming to ASTM A 615, A 185 or A 497, respectively;
 - f. Joints shall be sealed with preformed joint sealing compound conforming to ASTM C 990 and
 - g. Shipping of components shall not be initiated until a minimum compressive strength of 4,000 psi is attained or five (5) calendar days after fabrication has expired, whichever occurs first.
2. Internal Components shall conform to the following:
- a. The internal components shall include the center shaft and cone, dip plate, benching skirt, floatables lid, and component support frame.
 - 1) Materials of construction for the above components shall be cross-linked polyethylene (XLPE). The component support frame members and all metal parts shall be Type 304 stainless steel. All components shall be designed to withstand all normal loading associated with fabrication, shipping, site installation, and normal operation of the equipment. The component support frame shall withstand a live load of 500 lbs.
3. Frames and Covers (Solid Cover):
- a. Description: Castings of uniform quality, free from blow holes, porosity, hard spots, shrinkage defects, cracks, or other injurious defects. Manufactured true to pattern and free from surface imperfections. Provide machined horizontal bearing surfaces on heavy duty round frames and covers and fabricate round frames and covers in pavement of non-rocking design or with machined bearing surfaces. Grinds finish other units to proper fit. Apply shop coat of asphaltum to all units.
 - b. Cover – Solid:
 - 1) 30 inch open diameter
 - 2) Name of Stormwater Quality Unit manufacture cast into manhole cover.
 - 3) Lettering: “STORMWATER QUALITY UNIT”
 - c. Basis of Design: Similar to Frame Product #41600410 and Cover Product #00180841 by East Jordan Iron Works, Inc.
 - d. Material: Heavy Duty Round Frame and Covers, weight at least 350 lbs, meeting ASTM A 48/A 48M, Class 35B gray iron unless otherwise indicated.
 - e. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Neenah Foundry Co.
 - 2) East Jordan Iron Works, Inc (EJ Group, Inc.)

- 3) Campbell Foundry
- 4) General Foundries

4. Hatch systems

a. Description: Hatch shall be designed to withstand AASHTO H-20 loadings.

- 1) Hatch systems not subject to direct traffic shall be manufactured of Grade 5086 aluminum.
- 2) Hatch systems subject to direct traffic loads shall be manufactured of steel conforming to ASTM A 36-93a, supplied with a hot-dip galvanized finish conforming to ASTM A 123 and access doors bolted to the frame.

5. All piping and connections and ancillary items not listed herein shall be provided by the contractor.

6. Performance

a. The stormwater treatment unit shall adhere to the hydraulic parameters listed below and provide the removal efficiencies and storage capacities as follows:

Performance objective: The treatment chamber must be capable of treating a maximum flow at least equal to the peak treatment flow listed below.

<i>Treatment Unit Type:</i>	<i>Offline</i>	
<i>Peak Treatment Flow Rate (PTFR):</i>	3	<i>cfs</i>
<i>Max. Treatment Flow Rate (MTFR):</i>	1.56	<i>cfs</i>
<i>Vessel diameter:</i>	4	<i>ft.</i>
<i>Maximum inlet pipe diameter:</i>	12	<i>in.</i>
<i>Maximum overflow pipe diameter:</i>	12	<i>in.</i>
<i>Minimum storm drain depth:</i>	2.8	<i>ft.</i>
<i>Standard depth:</i>	4.1	<i>ft.</i>
<i>Max head loss* at peak treatment capacity:</i>	0.68	<i>ft.</i>
<i>Sediment storage capacity:</i>	0.70	<i>cu. yd.</i>
<i>Oil storage capacity:</i>	70	<i>gal.</i>
<i>Approximate empty weight:</i>	10,000	<i>lbs.</i>
<i>Approximate operational weight:</i>	13,200	<i>lbs.</i>

* Head loss is defined as the difference between static water level at the inlet to the stormwater treatment device to the free water surface in the overflow pipe assuming a free discharge.

- b. The stormwater treatment system shall be a hollow cylindrical vessel with internal components and a tangential inlet to induce a vortex flow pattern that will accumulate and store settleable solids in a sediment storage facility that is isolated from the treatment flow path. The sediment storage facility shall be beneath the vortex chamber to prevent re-entrainment of captured sediment and reduction in treatment capacity.
- c. Each stormwater treatment unit shall utilize a submerged inlet to prevent the re-entrainment of trapped floating contaminants without raising the water surface inside the tank.

- d. The stormwater treatment system shall have a floatables trap that is separate from the treated effluent discharge area to prevent re-entrainment of captured floatables during surcharge conditions.
 - e. The useable sediment and oil storage capacities shall not be less than the volumes listed above. The useable sediment storage capacity shall not cause a reduction in the volume of the treatment chamber capacity. The useable oil storage capacity shall not encroach upon the useable sediment storage capacity.
 - f. Access covers shall be provided for the sediment and floatable contaminant storage areas to facilitate maintenance.
7. Basis of Design Manufacturer
- a. The manufacturer of the storm water treatment device shall be one that is regularly engaged in the engineering design and production of systems deployed for the treatment of storm water runoff and which have a history of successful production, acceptable to the Architect and approved for use by the NYSDEC. The storm water treatment device shall be equivalent to the “Downstream Defender” device manufactured by: Hydro International, 94 Hutchins Drive, Portland, Maine 04102. Telephone: (207) 756-6200. Fax: (207) 756-6212.

2.22 IDENTIFICATION

A. Underground Warning Tape

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Presco, Inc.; Sherman, Texas
 - b. EMED Co., Buffalo, New York.
 - c. Seton Identification Products, A Tricor Direct Company.
2. Material: 6-inch wide, color-coded, heavy gauge 5-mil tape with aluminum backing.
3. All tapes printed with black ink on APWA (American Public Works Association) approved colors to meet or exceed industry standards.
4. Location: Provide warning tape 18 inches feet below finished grade in buried piping trenches and at foundation wall.

2.23 CONCRETE

- A. Cast-in-Place Concrete: Refer to Div 03 concrete section for concrete strength, mixtures, fiber reinforcement and other requirements.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavation, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.2 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
- C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
- D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.
- F. Install gravity-flow, nonpressure drainage piping according to the following:
 - 1. Install piping pitched down in direction of flow.
 - 2. Install piping with 24-inch minimum cover.
 - 3. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
 - 4. Install corrugated steel piping according to ASTM A 798/A 798M.
 - 5. Install PE corrugated sewer piping according to ASTM D 2321.
 - 6. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
- G. Install force-main pressure piping according to the following:
 - 1. Install piping with restrained joints at tee fittings and at horizontal and vertical changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.
 - 2. Install piping with 60-inch minimum cover.
 - 3. Install PVC pressure piping according to AWWA M23, or ASTM D 2774 and ASTM F 1668.

3.3 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, nonpressure drainage piping according to the following:
 - 1. Join hub-and-spigot, cast-iron soil piping with gasketed joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
 - 2. Join corrugated steel sewer piping according to ASTM A 798/A 798M.
 - 3. Join corrugated PE piping according to ASTM D 3212 for push-on joints.
 - 4. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasketed joints.
 - 5. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
 - 6. Join dissimilar pipe materials with nonpressure-type flexible couplings.
- B. Join force-main pressure piping according to the following:
 - 1. Join PVC pressure piping according to AWWA M23 for gasketed joints.
 - 2. Join dissimilar pipe materials with pressure-type couplings.

3.4 CLEANOUT INSTALLATION

- A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
 - 1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
 - 2. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
 - 3. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.
 - 4. Use Extra-Heavy-Duty, top-loading classification cleanouts in roads.
- B. Set cleanout frames and covers in earth in cast-in-place concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding earth grade.
- C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.5 DRAIN INSTALLATION

- A. Install type of drains in locations indicated.
 - 1. Use Light-Duty, top-loading classification drains in earth or unpaved foot-traffic areas.
 - 2. Use Medium-Duty, top-loading classification drains in paved foot-traffic areas.
 - 3. Use Heavy-Duty, top-loading classification drains in vehicle-traffic service areas.
 - 4. Use Extra-Heavy-Duty, top-loading classification drains in roads.
- B. Embed drains in 4-inch minimum concrete around bottom and sides.
- C. Fasten grates to drains if indicated.

- D. Set drain frames and covers with tops flush with pavement surface.
- E. Assemble trench sections with flanged joints.

3.6 MANHOLE INSTALLATION

- A. General: Install manholes, complete with appurtenances and accessories indicated.
- B. Install precast concrete manhole sections with sealants according to ASTM C 891.
- C. Where specific manhole construction is not indicated, follow manhole manufacturer's written instructions.
- D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops flush with finished surface elsewhere unless otherwise indicated.

3.7 CATCH BASIN INSTALLATION

- A. Construct catch basins to sizes and shapes indicated.
- B. Set frames and grates to elevations indicated.

3.8 DRY WELL INSTALLATION

- A. Excavate hole to diameter of at least 12 inches greater than outside of dry well. Do not extend excavation into ground-water table.
- B. Install precast, concrete-ring dry wells according to the following:
 - 1. Assemble rings to depth indicated.
 - 2. Extend rings to height where top of cover will be approximately 8 inches below finished grade.
 - 3. Backfill bottom of inside of rings with filtering material to level at least 12 inches above bottom.
 - 4. Extend effluent inlet pipe 12 inches into rings and terminate into side of tee fitting.
 - 5. Backfill around outside of rings with filtering material to top level of rings.
 - 6. Install cover over top of rings.

3.9 CONCRETE PLACEMENT

- A. Place and test cast-in-place concrete according to ACI 318 and Division 03 concrete section.

3.10 CONNECTIONS

- A. Connect nonpressure, gravity-flow drainage piping in building's storm building drains specified in Division 22 Section "Facility Storm Drainage Piping."
- B. Connect force-main piping to building's storm drainage force mains specified in Division 22 Section "Facility Storm Drainage Piping." Terminate piping where indicated.

C. Make connections to existing piping and underground manholes.

1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3,000 psi.
2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3,000 psi.
3. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes and structures by cutting into existing unit and creating an opening large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe, manhole, or structure wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.
 - a. Use concrete that will attain a minimum 28-day compressive strength of 3,000 psi unless otherwise indicated.
 - b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
4. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

D. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

1. Use non-pressure-type flexible couplings where required to join gravity-flow, non-pressure sewer piping unless otherwise indicated.
 - a. Unshielded flexible couplings for same or minor difference OD pipes.
 - b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
 - c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.
2. Use pressure-type pipe couplings for force-main joints.

3.11 CLOSING ABANDONED STORM DRAINAGE SYSTEMS

- A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:

1. Close open ends of piping with at least 8-inch thick, brick masonry bulkheads.
 2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.
- B. Abandoned Manholes and Structures: Excavate around manholes and structures as required and use one procedure below:
1. Remove manhole or structure and close open ends of remaining piping.
 2. Remove top of manhole or structure down to at least 36 inches below final grade. Fill to within 12 inches of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.
- C. Backfill to grade according to Division 31 Section "Earth Moving."

3.12 IDENTIFICATION

- A. Materials and their installation are specified in Division 31 Section "Earth Moving." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.
1. Use detectable warning tape over ferrous piping.
 2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.13 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
1. Submit separate reports for each system inspection.
 2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
 4. Reinspect and repeat procedure until results are satisfactory.
- B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
1. Do not enclose, cover, or put into service before inspection and approval.

2. Test completed piping systems according to requirements of authorities having jurisdiction.
 3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
 4. Submit separate report for each test.
 5. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
 - a. Exception: Piping with soil tight joints unless required by authorities having jurisdiction.
 - b. Option: Test plastic piping according to ASTM F 1417.
 - c. Option: Test concrete piping according to ASTM C 924.
- C. Leaks and loss in test pressure constitute defects that must be repaired.
- D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.14 CLEANING

- A. Clean interior of piping of dirt and superfluous materials. Flush with potable water.

END OF SECTION 33 41 00