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project manual

MAINE-ENDWELL CENTRAL SCHOOL DISTRICT

2022 Capital Improvement Project – Phase 5

Homer Brink Elementary School

project no. 23-44-7956

November 10, 2025

Issued for Bid: October 12, 2026

volume 2 of 2

set no.

Job No. 23-44-7956

PROJECT MANUAL

PROJECT

Maine-Endwell Central School District
2022 CAPITAL IMPROVEMENT PROJECT – PHASE 5
HOMER BRINK ELEMENTARY SCHOOL

K-12 Building: SED # 03-11-01-06-0-001-023

License Expiration Date: 5/31/2029

ARCHITECT

KING & KING ARCHITECTS LLP
358 West Jefferson Street
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(315) 682-6180

SEPTEMBER 30, 2029

CONSULTING ENGINEERS

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Registration current
through 9/30/2028

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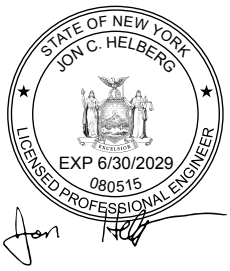

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2026.0
REGISTRATION 9.22
EXPIRATION: 09.30.2025

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To the best of our knowledge, information and belief, the plans and project manual are in accordance with applicable requirements of the New York State Uniform Fire Prevention and Building Code, the State Energy Conservation Construction Code and construction standards of the State Education Department and the New York State Department of Labor Industrial Code Rule 56.

Date: November 10th, 2025
Issued for Bid: October 12, 2026

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FOR

PROJECT

MAINE ENDWELL SCHOOL DISTRICT
2022 CAPITAL IMPROVEMENT PROJECT – PHASE 5
HOMER BRINK ELEMENTARY SCHOOL

Homer Brink Elementary School SED # 03-11-01-06-0-001-023

KING + KING ARCHITECTS, LLP
358 West Jefferson Street
Syracuse, New York 13202

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SECTION 220010 - BASIC PLUMBING REQUIREMENTS

1.0 PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All drawings and general provisions of Contract, including all General and Supplementary Conditions, Division 1 Specification Sections, and Instructions to Bidders apply to this section and all other sections of Division 22.

1.2 SCOPE OF WORK

A. Include in bid all labor, materials, tools, plant, transportation, excavation, equipment, insurance, temporary protection, permits, taxes and all necessary and related items required to provide complete and operational systems shown and described.

B. References to Codes and Standards called for in the Contract Documents mean the latest edition, amendment and revisions to the codes and standards in effect on the date of these Contract Documents.

C. Minimum composition requirements and/or installation methods for the following materials and work are included in this section:

1. Miscellaneous Supports.
2. Access Doors and Panels.
3. Fire Stopping.
4. Flashing and Sealing.
5. Cutting and Patching.

D. Contract shall include, but not be limited to:

1. Plumbing.

1.3 REGULATIONS AND CODE COMPLIANCE

A. All work and materials shall conform to and be installed, inspected and tested in accordance with the governing rules and regulations of federal, state and local governmental agencies.

B. The following is a list of Codes and Standards that will apply to this project:

1. 2020 Building Code of New York State (BCNYS).
2. 2020 Existing Building Code of New York State (EBCNYS).
3. 2020 Energy Conservation Construction Code New York State (ECCCNYS).

4. ASHRAE Standard 90.1-2016, Energy Standard for Buildings Except Low-Rise Residential Buildings.

5. 2020 Plumbing Code of New York State (PCNYS).

6. New York State Department of Labor Rules and Regulations.

7. New York State Department of Health.

8. Federal Occupational Safety and Health Administration - OSHA.

9. National Life Safety Code, NFPA 101.

10. Local Codes and Ordinances for Maine Endwell.

11. Underwriters Laboratory (UL).

12. Factory Mutual and/or Owner's Insurance Carrier.

13. New York State Education Department - "Manual of Planning Standards."

14. City of Maine Endwell Plumbing Department.

1.4 LICENSING & PERMITS

A. The Contractor shall hold a license to perform the work as issued by the State of New York.

B. Apply for and obtain all required permits and inspections, include costs for all fees and charges within bid.

C. Refer to General Conditions of the Contract for additional requirements.

1.5 GLOSSARY

ACI	American Concrete Institute
ADA	Americans with Disabilities Act
AGA	American Gas Association
AGCA	Associated General Contractors of America, Inc.
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AMCA	Air Moving and Conditioning Association
ANSI	American National Standards Institute
ARI	Air-Conditioning and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigeration and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASPE	American Society of Plumbing Engineers
ASTM	American Society for Testing Materials
AWSC	American Welding Society Code
AWWA	American Water Works Association
EIA	Electronic Industries Association

FCC	Federal Communications Commission
FM	Factory Mutual Insurance Company
IEEE	Institute of Electrical and Electronics Engineers
IRI	Industrial Risk Insurers
ISO	International Standards Organization
NEC	National Electrical Code
NEMA	National Electrical Manufacturers' Association
NESC	National Electrical Safety Code
NFPA	National Fire Protection Association
NYBFU	New York Board of Fire Underwriters
NYS/DEC	New York State Department of Environmental Conservation
NYS/UFBC	New York State Uniform Fire Prevention and Building Code
OSHA	Occupational Safety and Health Administration
SHI	Steel Boiler Institute
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
TIA	Telecommunications Industry Association
UFPO	Underground Facilities Protective Organization
UL	Underwriter's Laboratories, Inc.

1.6 DEFINITIONS

Approved / Approval	Written permission to use a material or system.
As Called For	Materials, equipment including the execution specified/shown in the contract documents.
Code Requirements	Minimum requirements.
Concealed	Work installed in pipe and duct shafts, chases or recesses, inside walls, above ceilings, in slabs or below grade.
Design Equipment	Refer to the article, BASIS OF DESIGN.
Design Make	Refer to the article, BASIS OF DESIGN.
Equal or Equivalent	Equally acceptable as determined by Owner’s Representative
Exposed	Work is not identified as concealed.
Final Acceptance	Owner acceptance of the project from Contractor upon certification by Owner's Representative.
Furnish	Supply and deliver to installation location.
Furnished by Others	Receive delivery at job site or where called for and install.
Inspection	Visual observations by Owner's site Representative.
Install	Mount and connect equipment and associated materials ready for use.
Labeled	Refers to classification by a standards agency.
Make	Refer to the article, BASIS OF DESIGN.
Or Approved Equal	Approved equal or equivalent as determined by Owner’s Representative.
Owner’s Representative	The Prime Professional
Prime Professional	Architect or Engineer having a contract directly with the Owner for professional services.
Provide	Furnish, install and connect ready for use.
Relocate	Disassemble, disconnect, and transport equipment to new locations, then clean, test, and install ready for use.
Replace	Remove and provide new item.

Review	A general contractual conformance check of specified products.
Rough-in	Pipe, duct, conduit, equipment layout and installation.
Satisfactory	As specified in contract documents.
Site Representative	Construction Manager or Owner's Inspector at the work site.

Refer to General Conditions of the Contract for additional definitions.

1.7 BASIS OF DESIGN

A. The contract documents are prepared on basis of one manufacturer as "design equipment," even though other manufacturers' names are listed as acceptable makes. If Contractor elects to use one of the listed makes other than "design equipment," submit detailed drawings, indicating proposed installation of equipment. Contractor shall make all necessary field measurements and investigations to assure that the equipment and assemblies will meet contract requirements. Show maintenance clearances, service removal space required, and other pertinent revisions to the design arrangement. Make required changes in work of all other trades, at no increase in any contract. Provide larger motors, electrical feeders, circuit breakers, equipment, additional control devices, valves, fittings and other miscellaneous equipment required for proper operation, and assume responsibility for proper location of roughing and connections by other trades. Remove and replace door frames, access doors, walls ceilings or floors required to install other than design make equipment. If revised arrangement submittal is rejected, revise and resubmit specified "design equipment" item which conforms to contract documents.

1.8 INTENT OF DRAWINGS

A. The drawings are diagrammatic, unless detailed dimensioned drawings are included. Drawings show approximate locations of equipment, and fixtures. Exact locations are subject to the approval of the Owner's Representative.

1.9 ELECTRONIC CAD DRAWING FILES

A. The Engineer may provide the Contractor with AutoCAD .dwg or MicroStation .dgn format files for this project with the understanding that these CAD files shall be used for reference purposes only, and not as shop drawings or as-built documents. It is the Contractors' responsibility to provide detailed, coordinated shop drawings and documentation prior to installation. The purpose of the Contractors' coordination shop drawings is to account for all trades and field conditions and identify any conflicts that shall be resolved prior to installation.

B. Any additional cost for changes due to conflicts as a result of the Contractors' failure to provide properly coordinated documents will be the responsibility of the Contractors and not of the Engineer.

C. A request must be made in writing to the Engineer with the requested individual files. The contractor will then be sent a CAD Release Form and must sign the form to obtain electronic drawings.

1.10 QUALITY ASSURANCE

A. Manufacturers of equipment shall be firms regularly and currently engaged in the production of equipment and accessories provided. The design and size of each item of equipment provided for this project needs to have been in satisfactory and efficient operation on at least three (3) installations for not less than three (3) years.

B. Suppliers of equipment must have factory trained and authorized personnel for the service of all equipment provided.

C. Apply and install materials, equipment, and specialties in accordance with manufacturer's written instructions. Conflicts between the manufacturer's instructions and the contract documents shall be referred to the Owner's Representative for resolution.

D. The contractor shall engage the services of a qualified installer for the installation and application of joint sealers, flashing, access panels, cutting and patching.

E. All work shall be done in a neat and workmanlike manner. All methods of construction, details of workmanship, which are not specifically described or indicated in the contract documents, shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

2.0 PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIAL MINIMUM REQUIREMENTS

A. Provide Materials That Meet the Following Minimum Requirements:

1. Materials shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less, in accordance with NFPA 255.

2. All equipment and material for which there is a listing service shall bear a UL label.

3. Potable water systems and equipment shall be built according to AWWA Standards.

4. Electrical equipment and systems shall meet UL Standards and requirements of the N.E.C. This listing requirement applies to the entire assembly. Any modifications to equipment to suit the intent of the specifications shall be performed in accordance with these requirements.

5. All materials, unless otherwise specified, shall be new and be the standard products of the manufacturer. Used equipment or damaged material will be rejected.

6. The listing of a manufacturer as “acceptable” does not indicate acceptance of a standard or catalogued item of equipment. All equipment and systems must conform to the Specifications.

2.2 SUBSTITUTIONS

A. The Materials, products and equipment described in the Bidding Documents establish a standard of required quality, functions, dimensions and appearance that must be met by any proposed substitution.

B. Proposed substitutions must be submitted in writing to the Architect and Engineer a minimum of ten (10) days prior to the date for receipt of Bids.

1. Each request shall include the name of the proposed material or equipment being substituted, cut sheets, installation drawings, performance and test data, warranties and location of three (3) similar installations with reference names of Owner or Facility personnel responsible for maintaining equipment.

2. At that time, the equipment will be evaluated and if determined to be acceptable an Addendum will be issued to all bidders.

C. Requests for substitution shall be made only by a Bidder. Requests for substitution from sales representatives, vendors or suppliers are unacceptable and will not be considered.

2.3 FACTORY-ASSEMBLED PRODUCTS

A. Provide maximum standardization of components to reduce spare part requirements.

B. Manufacturers of equipment assemblies which include components made by others shall assume complete responsibility for final assembled unit.

1. All components of an assembled unit need not be products of same manufacturer.

2. Constituent parts which are alike shall be product of a single manufacturer.

3. Components shall be compatible with each other and with the total assembly for intended service.

4. Contractor shall guarantee performance of assemblies of components, and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly.

C. Components of equipment shall bear manufacturer's name or trademark, model number and serial number on a name plate securely affixed in a conspicuous place, or cast integral with, stamped or otherwise permanently marked upon the components of the equipment.

D. Major items of equipment which serve the same function must be the same make and model. Exception will be permitted if performance requirements cannot be met.

2.4 COMPATIBILITY OF RELATED EQUIPMENT

A. Equipment and materials installed shall be compatible in all respects with other items being furnished and with existing items so that a complete and fully operational system will result.

2.5 MISCELLANEOUS SUPPORTS

A. Metal bars, plates, tubing, etc. shall conform ASTM standards:

1. Steel plates, shapes, bars, and grating - ASTM A 36

2. Cold-Formed Steel Tubing - ASTM A 500

3. Hot - Rolled Steel Tubing - ASTM A 501

4. Steel Pipe - ASTM A 53, Schedule 40, welded.

B. Metal Fasteners shall be Zinc-coated (type, grade and class as required)

2.6 ACCESS DOORS AND PANELS

A. Steel access doors and Frames shall be factory fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush.

B. Construction:

1. Frames:

a. 16 gage steel with 1-inch-wide exposed perimeter flange and adjustable masonry anchors for units installed in masonry, pre-cast, cast in place concrete, ceramic tile.

b. 16-gage steel, perforated flanges with bead for gypsum or plaster wall board.

c. 16-gage steel with galvanized expanded metal lath and exposed casing bead, welded to perimeter of frame for full bed plaster applications.

2. Access Doors:

a. Provide 14 gage sheet steel flush panel doors with concealed continuous piano hinge factory installed, primed and painted, set to open 175 degrees.

b. Provide fire rated, insulated flush panel doors, with continuous piano hinge and self-closing mechanism rated for 1-½ hour “B” labeled, in fire rated partitions.

3. Provide flush, screwdriver operated cam locks on all access doors.

2.7 FIRE STOPPING

A. Fire-stopping for Openings Through Fire and Smoke Rated Walls and Floor Assemblies shall be listed or classified by an approved independent testing laboratory for "Through-Penetration Fire-Stop Systems." The system shall meet the requirements of "Fire Tests of Through-Penetration Fire-Stops" designated ASTM E814.

B. Acceptable Manufacturers:

1. Dow Corning Fire-Stop System Foams and Sealants.

2. Nelson Electric Fire-Stop System Putty, CLK and WRP.

3. Thomas & Betts - S-100 FS500/600,

4. Carborundum Fyre Putty.

3.0 PART 3 - EXECUTION

3.1 SHOP DRAWINGS/PRODUCT DATA/SAMPLES

A. Submit Shop Drawings on all items of equipment and materials to be furnished and installed. Submission of Shop Drawings and samples shall be accompanied by a transmittal letter, stating name of project and contractor, number of drawings, titles, and other pertinent data called for in individual sections.

B. Shop drawings shall be dated and contain the following information. Incomplete submittals will not be accepted. Number each submittal.

1. Name of project.

2. Name of prime professional.

3. Name of prime contractor.

4. Description or names of equipment, materials and items; and complete identification of locations at which materials or equipment are to be installed.

C. All products specified in an individual Division 22 section shall be submitted at the same time.

D. Indicate deviations from contract requirements on Letter of Transmittal.

E. Corrections or comments made on the Shop Drawings during the review do not relieve Contractor from compliance with requirements of the drawings and specifications. The Contractor is responsible for confirming and correcting all quantities; checking electrical characteristics and dimensions; selecting fabrication processes and techniques of construction; coordinating his work with that of all other trades; and performing his work in a safe and satisfactory manner.

3.2 COORDINATION DRAWINGS

A. Before construction work commences, Contractors for all trades shall submit Coordination Drawings in the form of color-coded paper drawings or electronic files (dwg or rvt) not less than 3/8" = 1'-0" scale. Coordination Drawings are required throughout all areas for all trades. These drawings shall identify and show resolutions of trade conflicts. Mechanical Equipment Rooms shall be drawn early in the Coordination Drawing process, simultaneous with all other congested areas. Prepare Coordination Drawings As Follows:

1. HVAC Contract will prepare the base plan Coordination Drawings showing all ductwork and all pertinent piping and equipment. These drawings may be AutoCAD or Revit format of the required ductwork Shop Drawings. The drawings shall be coordinated with cable tray, lighting fixtures, sprinklers, air diffusers, other ceiling mounted items, ceiling heights, structural work, maintenance clearances, electric code clearance, reflected ceiling plans, and other contract requirements. Re-position proposed locations of work after coordination drawing review by the Construction Manager and the Architect. Provide adjustments to exact size, location and offsets of ducts, pipes, conduit, etc., to achieve reasonable appearance objectives. Provide these adjustments as part of Base Bid Contracts. Minor revisions need not be redrawn.

2. HVAC Contract will provide AutoCAD or Revit files and prints and submit the base plan to all major trades' Contractors.

3. Electrical, Plumbing and Fire Protection Contracts will draft location of piping, raceways, cable trays, light fixtures and equipment on the base plan, such hat a complete coordination of all trades is represented and areas of conflict and recommended resolutions are noted.

4. Do not install any equipment, equipment foundations, raceways, cable tray, lighting or cabling until Coordination Drawings have been approved. Failure to receive approval prior to installation of the aforementioned items, will put the risk on the contractor to remove and reinstall at the engineer’s discretion. Additional time spent by the engineer in the field reviewing construction progress due to not receiving coordination drawings prior, will be considered an additional service by the consultant, which shall be paid by the contractor and deducted from any moneys owed to the contractor. The consultant’s hourly rate will apply.

3.3 PROTECTION OF PERSONS AND PROPERTY

A. Contractor shall assume responsibility for Construction Safety at all times and provide, as part of contract, all trench or building shoring, scaffolding, shielding, dust/fume protection, mechanical/electrical protection, special grounding, safety railings, barriers, and other safety feature required to provide safe conditions for all workmen and site visitors.

3.4 EXISTING SYSTEMS AND CONDITIONS

A. Prior to beginning work inspect and test all existing systems that will be affected by the work in this contract. Provide a report to the Owner indicating any problems or defects found. If no problems or system defects are submitted, the contractor shall be responsible for correcting problems found at the completion of the project that are determined to be caused by the work of this contract.

B. Inspect the entire work area for defects in the existing construction such as scratches, holes etc. Submit a complete list and photographs of existing damage, to the Owner prior to beginning work. If existing damage is not documented the contractor shall repair all damage to like new condition, which is determined to have been caused by the work in this contract.

C. The Owner's representative shall determine if the contractor has damaged existing systems or construction and approve the repairs.

3.5 ASBESTOS RECOGNITION AND PRECAUTIONS

A. The contractor shall be responsible for coordination of all required removal work, coring, cutting and patching with the Owner's asbestos management plan. Prior to performing such work identify areas containing asbestos, notify the Owner so that they may make arrangements for abatement and/or containment prior to work proceeding. The contractor shall be responsible for cleaning all areas where asbestos is released due to the failure to coordinate with the asbestos management plan. Refer to Division 1 sections for further requirements.

B. The disturbance or dislocation of asbestos-containing materials causes asbestos fibers to be released into the building's atmosphere, thereby creating a health hazard to workmen and building occupants. Consistent with Industrial Code Rule 56 and the content of recognized asbestos-control work, the Contractor shall apprise all of his workers, supervisory personnel, subcontractors, Owner and Consultants who will be at the job site of the seriousness of the hazard and of proper safeguards and work procedures which must be followed, as described in New York State Department of Labor Industrial Code Rule 56.

C. Refer to Division 2 Sections for further requirements.

3.6 REMOVALS

A. Where existing equipment removals are called for, submit complete list to Owner's Representative. All items that Owner wishes to retain that do not contain asbestos material shall be delivered to location directed by Owner. Items that Owner does not wish to retain shall be removed from site and legally disposed of. Removal and disposal of material containing asbestos shall be in accordance with Federal, State and Local law requirements. Where equipment is called for to be relocated, Contractor shall carefully remove, clean and recondition, then reinstall. Remove all abandoned piping, wiring, equipment, tubing, supports, fixtures, etc. Visit each room, crawl spaces and roofs to determine total Scope of Work.

B. Completely remove all piping, controls, and other devices associated with the equipment not to be reused in the new work. This includes all pipe, valves, fittings, insulation and all hangers, including the top connection and any fastenings to building structural systems. Seal all openings, after removal of equipment, pipes, conduits and other penetrations in roof, walls, floors, in an approved manner and in accordance with plans and specifications where specifically covered. Structural integrity of the building system shall be maintained. Reference shall also be made to the architectural, structural, mechanical, site, and electrical drawings and specifications for additional facilities to be demolished or handled.

C. Ream pipes after cutting and clean before installing. Cap or plug equipment and pipe openings during construction.

3.7 FREEZING AND WATER DAMAGE

A. Take all necessary precautions with equipment, systems and building to prevent damage due to freezing and/or water damage. Repair or replace, at no change in contract, any such damage to equipment, systems and building. Perform first seasons winterizing in presence of Owner's operating staff.

3.8 ROUGH-IN

A. Due to small scale of Drawings, it is not possible to indicate all offsets, fittings, changes in elevation, etc. Verify final locations for rough-ins with field measurements and with the equipment being connected. Verify exact location and elevations at work site prior to any rough in work. **DO NOT SCALE PLANS**. If field conditions, details, changes in equipment or shop drawing information require a significant change to the original documents, contact the Owner’s representative for approval before proceeding.

B. All equipment locations shall be coordinated with other trades to eliminate interference with required clearances for equipment maintenance and inspections.

1. Coordinate work with other trades and determine exact routing of all duct, pipe, conduit, etc., before fabrication and installation. Coordinate with Architectural Drawings. Verify with Owner's Representative exact location and mounting height of all equipment in finished areas, such as thermostats, fixtures, communication and electrical devices, including panels. Coordinate all work with the architectural reflected ceiling plans and/or existing Architecture. Mechanical and electrical drawings show design arrangement only for Diffusers, grilles, registers, air terminals, lighting fixtures, sprinklers, speakers and other items. Do not rough-in-contract work without reflected ceiling location plans.

2. Before roughing for equipment furnished by Owner or in other contracts, obtain from Architect and other Contractors, approved roughing drawings giving exact location for each piece of equipment. Do not "rough in" services without final layout drawings approved for construction. Cooperate with other trades to ensure proper location and size of connections to ensure proper functioning of all systems and equipment. Obtain written authorization from the Owner's representative or other contractor for any "rough ins" that, due to project schedule, are required before approved coordination drawings are available. Any work installed without written authorization or approved coordination drawings, causing a conflict will be relocated by this contractor at no expense to the Owner.

3. For equipment and connections provided in this contract, prepare roughing drawings as follows:

   a. Existing equipment being relocated: Measure the existing equipment and prepare drawings for installation in new location.

   b. New equipment: Obtain equipment roughing drawings and dimensions, then prepare rough-in drawings.

4. Where more than one trade is involved in an area, space or chase, all shall cooperate and install their own work to utilize the space equally between them in proportion to their individual requirements. In general, ductwork shall be given preference except where grading of piping becomes a problem, followed by piping then electrical wiring. If, after installation of any equipment, piping, ducts, conduit, and boxes, it is determined that ample maintenance and passage space has not been provided, rearrange work and/or furnish other equipment as required for ample maintenance space. Any changes in the size or location of the material or equipment supplied, which may be necessary in order to meet field conditions or in order to avoid conflicts between trades, shall be brought to the immediate attention of the Owner's Representative and approval received before such alterations are made.

C. Provide easy, safe, and code mandated clearances at controllers, motor starters, valve access, and other equipment requiring maintenance and operation. Contractor shall relocate existing work in the way of new construction. VISIT SITE BEFORE BIDDING TO DETERMINE SCOPE OF WORK. Provide new materials, including new piping and insulation for relocated work.

3.9 CUTTING AND PATCHING

A. Each trade shall include their required cutting and patching work unless shown as part of the General Construction work on the architectural drawings. Refer to "General Conditions of the Contract for Construction," for additional requirements. Cut and drill from both sides of walls and/or floors to eliminate splaying. Patch, cut or abandoned holes left by removals of equipment or fixtures. Patch adjacent existing work disturbed by installation of new work including insulation, walls and wall covering, ceiling and floor covering, other finished surfaces. Patch openings and damaged areas equal to existing surface finish. Cut openings in prefabricated construction units in accordance with manufacturer's instructions.

3.10 CONCEALMENT

A. Conceal all contract work above ceilings and in walls, below slabs, and elsewhere throughout building. If concealment is impossible or impractical, notify Owner's Representative before starting that part of the work and install only after his review. In areas with no ceilings, install only after Owner's Representative reviews and comments on arrangement and appearance.

3.11 ACCESS DOORS AND PANELS

A. Install access doors, sized to permit complete access for any concealed and/or inaccessible junction boxes, control and monitoring devices, valves and other plumbing equipment requiring access for maintenance or operation.

B. Set frames accurately in position and securely attach to supports with face panels plumb and level in relation to adjacent finish surfaces.

C. Adjust hardware and panels after installation for proper operation.

3.12 CHASES

A. New Construction:

1. Certain chases, recesses, openings, shafts, and wall pockets will be provided as part of "General Building Construction Plans and Specifications." Mechanical and Electrical Trades work shall provide all other openings required for their contract work.

2. Check Architectural and Structural Design and Shop Drawings to verify correct size and location for all openings, recesses and chases in general building construction work.

3. Assume responsibility for correct and final location and size of such openings.

4. Rectify improperly sized, improperly located or omitted chases or openings due to faulty or late information or failure to check final location.

5. Provide 18-gauge galvanized sleeves and inserts. Extend all sleeves 2 inches above finished floor. Set sleeves and inserts in place ahead of new construction, securely fastened during concrete pouring. Correct, by drilling, omitted or improperly located sleeves. Assume responsibility for all work and equipment damaged during course of drilling. Firestop all unused sleeves.

6. Provide angle iron frame where openings are required for contract work, unless provided by General Construction Contractor.

B. In Existing Buildings:

1. Drill holes for floor and/or roof slab openings.

2. Multiple pipes smaller than 1" properly spaced and supported may pass through one 6" or smaller diameter opening.

3. Seal voids in fire rated assemblies with a fire-stopping seal system to maintain the fire resistance of the assembly. Provide 18-gauge galvanized sleeves at fire rated assemblies. Extend sleeves 2 inches above floors.

4. In wall openings, drill or cut holes to suit. Provide 18-gauge galvanized sleeves at shafts and fire rated assemblies. Provide fire-stopping seal between sleeves and wall in drywall construction. Provide fire-stopping similar to that for floor openings.

3.13 FIRE-STOPPING

A. Fire-stopping for Openings Through Fire and Smoke Rated Wall and Floor Assemblies:

1. Provide materials and products listed or classified by an approved independent testing laboratory for "Through-Penetration Fire-Stop Systems." The system shall meet the requirements of "Fire Tests of Through-Penetration Fire-Stops" designated ASTM E814.

2. Provide fire-stop system seals at all locations where piping, tubing, conduit, electrical busways/cables/wires, and similar utilities pass through or penetrate fire rated wall or floor assembly. Provide fire-stop seal between sleeve and wall for drywall construction.

3. The minimum required fire resistance ratings of the wall or floor assembly shall be maintained by the fire-stop system. The installation shall provide an air and watertight seal.

4. The methods used shall incorporate qualities, which permit the easy removal or addition of electrical conduits or cables without drilling or use of special tools. The product shall adhere to itself to allow repairs to be made with the same material and permit the vibration, expansion and/or contraction of any items passing through the penetration without cracking, crumbling and resulting reduction in fire rating.

5. Apply fire stopping within the temperature and humidity limits permitted by the manufacturer.

6. Provide rigid steel sleeves where non-armored cables pass through fire rated walls and barriers.

3.14 FLASHING AND SEALING

A. Opening through roofs shall be flashed in manner not to affect roof guarantee or bond. Engage qualified Roofing Contractor licensed by the Roofing manufacturer, as part of contract. Provide non-ferrous flashing pieces, skirts, hoods and collars as required to make pipes, conduits, and other penetrations watertight. Where curbs are called for with respect to rectangular openings in new roofs, flashing will be done by others unless specifically indicated otherwise. Caulk and waterproof with additional material so as to seal airtight and watertight.

B. Apply all flashing and sealers within the temperature and humidity limits permitted by the manufacturer.

3.15 SUPPORTS

A. Provide required supports, beams, angles, hangers, rods, bases, braces, and other items to properly support contract work. Supports shall meet the approval of the Owner's Representative. Modify studs, add studs, add framing, or otherwise reinforce studs in metal stud walls and partitions as required to suit contract work. If necessary, in stud walls, provide special supports from floor to structure above. For Precast Panels/Planks and Metal Decks, support plumbing work as determined by manufacturer and Owner's Representative. Provide heavy gauge steel mounting plates for mounting contract work. Mounting plates shall span two or more studs. Size, gauge, and strength of mounting plates shall be sufficient for equipment size, weight, and desired rigidity.

3.16 PAINTING

A. This Contract Includes the following:

1. Painting for all cut and patch work performed as part of Division 22 contract.

2. Painting required for touch-up of surfaces damaged due to the installation of division 22 work.

3. Painting as required to repair finish of equipment furnished.

4. Refer to Division 9 Sections for general description of materials and methods.

5. Painting as called for on Division 22 Drawings.

3.17 ADDITIONAL ENGINEERING SERVICES

A. In the event that the Consultant is required to provide additional engineering services as a result of substitution of equivalent materials or equipment by the Contractor, or changes by the Contractor in dimension, weight, power requirements, etc., of the equipment and accessories furnished, or if the Consultant is required to examine and evaluate any changes proposed by the Contractor for the convenience of the Contractor, then the Consultant's expenses in connection with such additional services shall be paid by the Contractor and may be deducted from any moneys owed to the Contractor.

B. In the event that the Consultant is required to provide additional engineering services as a result of Contractor's errors, omissions or failure to conform to the requirements of the Contract Documents, or if the Consultant is required to examine and evaluate any changes proposed by the Contractor solely for the convenience of the Contractor, then the Consultant's expense in connection with such additional services shall be paid by the Contractor and may be deducted from any moneys owed to the Contractor.

C. In the event the Consultant is required to initiate design changes due to failure of the contractor to properly coordinate with the construction schedule, and / or other trades, then the Consultant's hourly rate and expenses in connection with such additional services shall be paid by the Contractor and shall be deducted from any moneys owned to the Contractor.

3.18 ALL TRADES TEMPORARY HEAT

A. Refer to the Standard General Conditions of the Contract for Construction and Supplemental General Conditions.

3.19 TEMPORARY FACILITIES

A. Refer to the standard General Conditions of the contract for Construction and Supplemental General Conditions.

1. Continuity of operation of existing facilities will require temporary installation or relocation of equipment and piping.

2. All piping and equipment shall be properly supported, sloped to drain, operate without excessive stress, and shall be insulated where injury can occur to personnel by contact with operating facilities.

3. Temporary facilities and piping shall be completely removed and any openings in structures sealed. Provide necessary blind flanges and caps to seal open piping remaining pressurized.

3.20 CLEANING

A. It is the Contractor's responsibility to keep clean all equipment and fixtures provided under this contract for the duration of the project. Each trade shall keep the premises free from an accumulation of waste material or rubbish caused by his operations. The facilities require an environment of extreme cleanliness, and it is the Contractor's responsibility to adhere to the strict regulations regarding procedures on the existing premises. After all tests are made and installations completed satisfactorily:

1. Thoroughly clean entire installation, both exposed surfaces and interiors.

2. Remove all debris caused by work.

3. Remove tools, surplus, materials, when work is finally accepted.

3.21 PLUMBING EQUIPMENT CONNECTIONS

A. Provide complete plumbing connections to all plumbing equipment. Provide control connections to equipment where indicated on the drawings. Provide valves on piping ahead of each piece of equipment.

B. Provide all piping, trim, accessories and connections as required for proper equipment operation of Equipment provided by this contract, Owner-Furnished Equipment and Equipment furnished by other contracts,

C. Refer to Manufacturer's drawings/specifications for requirements of special equipment. Verify connection requirements before bidding and confirm prior to roughing.

3.22 PLUMBING INSTALLATIONS

A. All installations shall comply with the following requirements:

1. Coordinate plumbing systems, equipment, and materials installation with other building components. Be responsible for any changes in openings and locations necessitated by the equipment installed.

2. The Architect shall control the placement of all wall and ceiling mounted plumbing equipment and devices in all rooms with the exception of mechanical and electrical equipment rooms. When drawing details are not available, consult with the Architects representative for actual location.

3. Verify all dimensions with field measurements.

4. Arrange for all chases, slots and openings in other building components, which are not indicated on drawings, to allow for plumbing installations.

5. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.

6. Coordinate ordering and installation of all equipment with long lead times or having a major impact on work by other trades so as not to delay the job or impact the construction schedule.

7. Where mounting heights are not detailed or dimensioned, install systems, materials and equipment to provide the maximum headroom possible.

8. Install systems, materials and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer the conflict to the Architect.

9. Store Materials on dry base, at least 6" above-ground or floor. Store so as not to interfere with other work or obstruct access to buildings or facilities. Provide waterproof/windproof covering. Remove and provide special storage for items subject to moisture damage. Protect against theft or damage from any cause. Replace items stolen or damaged, at no cost to Owner.

10. Set all equipment to accurate line and grade, level all equipment and align all equipment components.

11. All tolerances in alignment and leveling, and the quality of workmanship for each stage of work shall be as required by the manufacturer and subject to approval by the Owner’s representative.

12. All finished equipment surfaces damaged during construction shall be brought to "as new" condition by touch up or repainting. Any rust shall be removed and primed prior to repainting.

13. Provide all scaffolding, rigging, hoisting and services necessary for erection and delivery of equipment and apparatus furnished into the premises. These items shall be removed from premises when no longer required.

14. No plumbing equipment shall be hidden or covered up prior to inspection by the Owner's representative. All work that is determined to be unsatisfactory shall be corrected immediately.

15. All plumbing work shall be installed level and plumb, parallel and perpendicular to other building systems and components.

16. Conceal all contract work above ceilings and in walls, below slabs, and elsewhere throughout building. If concealment is impossible or impractical, notify Owner's Representative before starting that part of the work and install only after his approval. In areas with no ceilings, install only after Owner's Representative reviews and comments on arrangement and appearance.

17. Install access panels or doors where units are concealed behind finished surfaces.

3.23 CONTINUITY OF SERVICES

A. The building will be in use during construction operations. Maintain existing systems in operation within all rooms of building at all times. Refer to "General Conditions of the Contract for Construction" for temporary facilities for additional contract requirements. Schedules for various phases of contract work shall be coordinated with all other trades and with Owner's Representative. Provide, as part of contract, temporary plumbing and electrical connections and relocation as required to accomplish the above. Obtain approval in writing as to date, time, and location for shut-down of existing facilities or services.

3.24 START UP AND OWNER INSTRUCTIONS

A. Before acceptance of the work, furnish necessary skilled labor to operate all systems by seasons. Instruct the Owner's designated personnel on the proper operation and maintenance of systems and equipment. Obtain written acknowledgment from person instructed prior to acceptance repeat the instructions if asked to do so. Contractor is fully responsible for systems until acceptance, even though operated by Owner's personnel, unless otherwise agreed in writing. Provide operating, maintenance and starting precautions and procedures to be followed by the Owner for operating systems and equipment. Mount the instruction in clear plastic holder on or adjacent to the equipment.

B. Where supervision by a manufacturer is called for, provide manufacturer's certified technician or engineer to supervise the startup, testing and adjustment of the equipment or system. Where two or more manufacturers are involved (i.e., variable frequency drive and pumps) both manufacturers shall be present at start up. The manufacturer shall provide a written report detailing the testing and start-up including problems that occurred and their method of resolution.

C. Refer to Division 1 Sections for additional requirements.

3.25 OPERATION AND MAINTENANCE MANUALS

A. Provide Operation and Maintenance Manuals. Include one copy each of approved Shop Drawings, wiring diagrams, piping diagrams, spare parts lists, as-built drawings and manufacturer's instructions. Include typewritten instructions, describing equipment, starting/operating procedures, emergency operating instructions, seasonal changeover, freeze protection, precautions and recommended maintenance procedures. Include name, address, and telephone number of supplier manufacturer Representative and service agency for all major equipment items. Bind above items in a three ring binder with name of project on the cover. Deliver to Owner's Representative before request for acceptance.

3.26 RECORD DOCUMENTS

A. Prepare and provide record documents in accordance with Division 1 Sections. In addition to those requirements provide the following:

1. Utilities below floors, slabs and grade: During construction, maintain accurate records of all final locations and inverts for all services inside and outside of the buildings, beneath grade and below floors.

2. Take dimensions from a given fixed benchmark, such as the corner of a building, and neatly and clearly indicate same on Record Drawings.

3. Provide Record Drawings for all Contract Work.

4. Incorporate all field changes, change orders and other modifications into the final Record Drawings.

END OF SECTION 220010

SECTION 220501 - EXCAVATION AND BACKFILL

1.0 PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment, and services to perform operations required for the complete installation and related work as required in the Contract Documents.

B. Obtain necessary permits and pay fees and charges for same.

1.2 SUBMITTALS

A. Material test reports from a qualified testing agency, as required by Owner's Representative.

1.3 QUALITY ASSURANCE

A. Comply with local, state, and federal codes, regulations, and laws affecting work of this section.

B. Testing and inspections: Testing and inspection procedures shall be as required by the Owner's Representative.

C. Comply with Code Rule 53 of the New York State Law.

2.0 PART 2 - PRODUCTS

2.1 MATERIALS

A. Cushion Sand: Clean, coarse, free of organic matter, conforming to New York State DOT Item No. 703-06.

B. Crushed Stone: Crushed stone, graded, free of organic materials, No. 1 to No. 4 size. Conforming to New York State DOT Item No. 703-0201.

C. Gravel Fill: Well-graded natural inorganic sand and gravel conforming to New York State DOT Item No. 703-0202.

D. Ordinary Fill: Well-graded, natural soil, meeting the following requirements:

1. Free of organic and other compressible materials, debris and frozen materials, and of stones larger than 4 in. maximum dimension.

2. Be of such nature and character that it can be compacted to the specified densities.

3. Free of highly plastic clays, of materials subject to decay, decomposition, or dissolution, and of cinders, ash and other corrosive materials.

4. Maximum dry density of not less than 115 lbs. per cu. ft.

5. Material from excavation on the site may be used as ordinary fill if it meets the above requirements.

3.0 PART 3 - EXECUTION

3.1 PREPARATORY WORK, SCHEDULING SHUTDOWNS, AND TEMPORARY WORK

A. Build lines to grade and elevations shown. Provide stakes, grade boards, cleats, nails, instruments. Locate and stake each new run for its entire length. Verify elevations given. Start excavation at low point. Notify Engineer of elevation discrepancies. Protect marks and stations.

B. Before starting excavating work, coordinate with Owner's Site Representative and furnish schedule of operations to Owner. Provide and maintain temporary walks and bridges over excavations where underground utility lines, sewers, water lines, etc., cross work area. Make necessary arrangement with authorities having jurisdiction.

C. Do not interrupt utilities serving facilities unless permitted in writing by Owner’s representative. Do not proceed with utility interruptions without written permission. Notify Owner’s representative not less than two days in advance of proposed utility interruptions.

D. Avoid cutting outside project work area without Owner’s permission. Protect adjacent spaces from damage. Accept responsibility for damages outside of the work area.

E. Remove existing piping, slabs, within construction path and as shown on Contract Drawings, unless directed otherwise.

1. Cap or plug with brick and mortar, as indicated, pipes and other conduits abandoned due to demolition.

2. Materials and appurtenances removed, that are not designated for relocation, or future use by the Owner shall become property of Contractor. Haul from site and dispose of at no additional compensation.

F. Store at a site designated by the Owner, items in reusable condition as determined by the Engineer.

3.2 PROTECTION

A. Provide bracing, shoring, sheathing and other work for protection of personnel, the contract work, excavations, existing structures, and surrounding properties. Provide, erect, and maintain barricades, warning signs, flags, and lights to provide protection for work, workmen, public, and property. Plank walks, pavements, and curbs to be crossed by equipment. Protect adjacent structure, property and other items:

1. Restore, repair, rebuild or replace any such items damaged or destroyed to condition equal to that existing before such damage occurred.

B. Wet down work during demolition operations to prevent dust from arising.

3.3 DEWATERING

A. Provide pumps, hoses, pipe, labor and fuel, necessary to keep excavations free of water accumulation. Maintain and operate equipment. Discharge water in manner not interfering with and not to undermine or disturb existing or adjacent structures or land. Grade to prevent surface water from flowing into all excavations and trenches. Do not discharge dirt, backfill, debris, into sanitary or storm drainage systems.

1. Do not use excavated trenches as temporary drainage ditches.

B. If subgrade soils are disturbed or become unstable due to dewatering operation or an inadequate dewatering system, notify Engineer and Owner's Representative. Stabilize the subgrade and modify system to perform as specified at no additional cost.

C. If oil and/or hazardous materials are encountered after dewatering begins, immediately notify Engineer and Owner's Representative.

3.4 EXCAVATION

A. Excavate to proper depth and width for installation work as called for and comply with rules set forth by New York State Departments of Labor and Transportation. Remove materials including masonry work, rubble, earth, brickwork, concrete, sand, debris, abandoned pipe lines, drains and sewers, rocks, boulders, and concrete, all of which is considered "earth excavation". Provide for legal disposition of excess excavated materials. Make allowance for gravel fill, sand bases, thrust blocks, sheet piling, drainage pumps, and work space. Start excavation at rough grade and provide form work and sheet piling where required.

B. Excavate by hand in proximity to existing underground utility lines; take extreme care when excavating around ductbanks carrying energized cable. Remove, plug or cap inactive or abandoned utilities encountered during construction operations. The location of such utilities shall be noted on the record drawings. Verify "inactivity" of services with involved jurisdiction before start of work.

C. Trench excavation:

1. By open cut, to proper depth and grade no wider than required for placement of work and not more than 100 feet in advance of utility being installed.

2. Excavate trenches to uniform widths to provide a working clearance on each side of pipe.

3. Excavate and clean trench bottoms to receive bedding materials and to provide uniform bearing and support of pipes. Remove projecting stones and sharp objects along trench subgrade.

4. Should trench bottom be wet, unstable, and/or otherwise incapable of supporting the contract work, immediately report same to Owner's Representative. Should it be deemed unsuitable, excavate to depth as directed and backfill with gravel to trench depth, or provide concrete cradling.

5. Should rock be encountered, excavate 6 inches deeper and fill space between trench bottom and pipe with coarse sand, well tamped to form firm bed.

D. Shoring, bracing, sheathing:

1. In addition to governing codes, protect sides of excavations with sheeting and bracing where necessary to prevent sliding or caving of banks and to protect adjacent structures. Remove as backfill is placed.

2. Provide at locations adjacent to existing structures, and similar items.

3.5 STORAGE OF SOIL MATERIALS

A. Where permitted, stockpile borrow materials and satisfactory excavated soil materials at location designated by Owner's Representative. Stockpile soil materials without intermixing. Stockpile soil materials away from edge of excavations.

B. Any excess borrow materials or satisfactory soil materials not required for the project shall be hauled offsite and legally disposed of at the Contractor's expense unless otherwise indicated on the drawings and technical specifications.

3.6 BACKFILL - GENERAL

A. Bedding:

1. Shape bedding course to provide continuous support for bells, joints and barrels of pipes, and for joints and fittings.

2. Place around piping with coarse sand from 6 inches below to 8 inches above. Apply by hand and compact under and at sides by mechanical means.

3. Piping, jackets and sand bed must be inspected and tested prior to backfill of any nature. Provide necessary anchors, thrust blocks, for testing.

4. Do not place bedding on surfaces that are muddy, frozen or contain frost or ice.

B. Remainder of trench:

1. Fill remainder of trench in 12 inch layers, use ordinary fill material, except as otherwise specified. Do not use frozen material. Remove boulders, stones, broken rock, wood, bricks, blocks, and debris from fill material before backfill operation.

2. Bring backfill evenly up on both sides and along the full length of piping to avoid damage or displacement of utility system.

3. Coordinate backfilling with utilities testing.

4. Do not place backfill on surfaces that are muddy, frozen or contain frost or ice.

C. Under slabs on grade and at utility entrance to building:

1. Backfill in 6 inch layers with gravel or crushed stone, free from organic or other unsuitable material, to grade. Thoroughly compact each layer.

D. Compaction Requirements:

1. Compaction to not less than 95% density compared to maximum laboratory tests by weight, per modified ASTM D1557-64T, latest editions, method "A" under slab on grade, and 85% for general grading. Submit certified results of tests by an approved soil testing laboratory.

3.7 FIELD QUALITY CONTROL

A. Testing and inspections: Testing and inspection procedures shall be as determined by the Owner's Representative.

B. Allow testing agency to inspect and test each base, fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed Work complies with requirements.

C. Testing agency will test compaction of soils in place according to ASTM D1556, ASTM D2167, ASTM D2922 and ASTM D2937, as applicable. Tests will be performed at the following frequencies:

1. Trench backfill: At each compacted initial and final backfill layer, at least one test for each 50 feet or less of trench length, but no fewer than two tests.

D. When testing agency reports that bases, subbases, 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.

E. The number of tests and test frequency may be increased at any location or during any phase of work, if deemed appropriate by the Owner's Representative.

3.8 COMPLETION

A. On completion of the work, clean the entire site, remove surplus earth, trash, large stones and debris, to off-site legal disposal. Remove tools and equipment and leave the entire area in a neat condition.

B. Concrete Slab Floors:

1. Rough grade to 6 inches below bottom of floor slab. Refer to details shown on Contract Drawings. Placement, curing and finish of concrete slabs by Others.

END OF SECTION 220501

SECTION 220502 - PLUMBING PIPING SYSTEMS AND ACCESSORIES

1.0 PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services to perform operations required for the complete installation and related Work as required in Contract Documents.

1.2 SUBMITTALS

A. Schedule of all pipe materials, fittings and connections to be utilized on this Project.

1. Pipe and fitting material data sheets identifying compliance with specified approvals and listings.

2.0 PART 2 - PRODUCTS

2.1 GENERAL

A. All piping and fittings used on this Project shall be new and marked with manufacturer's name; and shall comply with all applicable ASTM and ANSI Standards.

B. All water distribution pipe and fittings shall conform to NSF-61.

C. All drinking water system components, including pipe and fittings, shall conform to NSF-372.

2.2 COPPER PIPE AND SOLDER FITTINGS

A. Pipe, Above ground: Hard temper, ASTM B88; Type K, L, M, or DWV, as called for. Soft temper only as called for. Plans show copper tube sizes.

B. Pipe, Below ground: Soft temper, ASTM B88; Type K. Hard temper, ASTM B88; Type DWV. Plans show copper tube sizes.

C. Copper is not allowed for urinal waste (above or below ground).

D. Tees, Elbows, Reducers: Wrought copper; solder end connections; ASME B16.22; ASTM B828.

1. Cast copper alloy fittings are prohibited for medical vacuum piping systems.

E. Unions And Flanges:

1. 2 inch and smaller: Unions, solder type, wrought copper, ground joint, 150 lb. swp.

2. 2-1/2 inch and larger: Flanged, wrought copper, companion type, ASME drilled, solder connection, 150 lb. swp.

F. Solder Materials: No-lead solder, using alloys made from tin, copper, silver and nickel.

1. No-lead solder and flux shall comply with requirements of NSF-372, ASTM B813, ASTM B32.

2. Make: Harris "Bridgit", Lucas-Milhaupt Warwick "Silverbright 100", Canfield Technologies "100% Watersafe".

2.3 SOIL PIPE AND FITTINGS

A. Pipe: ASTM A74 service weight cast iron, coated.

B. Fittings: Service weight type with “push-on” type fittings with ASTM C564 extra heavy neoprene gasket of same manufacturer as piping.

C. No-Hub:

1. Pipe: ASTM A888 no-hub cast iron, coated.

2. Fittings: Cast iron no-hub pattern with neoprene gasket and 24 gauge, Type 304 stainless steel heavy duty clamp assembly; ASTM C1540.

a. Make: Charlotte Pipe, Clamp-All, Husky, Tyler “Widebody”.

2.4 SPECIAL FITTINGS

A. Copper To Cast Iron: Cast bronze, cast iron to sweat adapter.

B. No-Hub, Cast Iron: Proper adapter to piping being connected.

2.5 DIELECTRIC PIPE FITTINGS

A. Tensile strength, ASME B16.8, union 250 psi, or flange design, 175 psi, pressure rating, at 210 Deg. F, threaded or solder joint, constructed to prevent gasket from squeezing into internal opening.

B. Acceptable Manufacturer: Epco, Capitol Manufacturing, Watts, or approved equal.

2.6 HANGERS, INSERTS AND SUPPORTS

A. Hangers, Inserts, Clamps: Anvil International, Carpenter & Patterson, Cooper B-Line, PHD Manufacturing.

B. Hangers:

1. Adjustable, wrought malleable iron or steel. Copper plated or PVC coated where in contact with copper piping. Cadmium plated or galvanized for non-copper piping.

2. Adjustable ring type where piping is installed directly on hanger for piping 3 inch and smaller.

3. Adjustable steel clevis type for piping 4 inch and larger.

4. Nuts and rods with electroplated zinc or cadmium (0.005 inch minimum) finish.

C. Spacing Schedule:

1. Pipe Hangers:

a. Plumbing Piping: Hanger spacing shall comply with Section 308 and Table 308.5 of the 2020 Plumbing Code of New York State (PCNYS).

b. Fuel Gas Piping: Hanger spacing shall comply with Section 407, Section 415 and Table 415.1 of the 2020 Fuel Gas Code of New York State (FGCNYS).

2. Cast-iron pipe: Each horizontal joint, 5-feet maximum O.C.

3. For medical gas systems, refer to other Division 22 Sections for pipe hanger spacing requirements.

D. Cast Iron No-Hub Supports:

1. In accordance with manufacturers recommendations.

2. Vertical piping supported at each stack base and at each floor. Freestanding vertical pipe should be adequately staked or braced during construction to maintain alignment. Bases of stacks shall be supported on concrete, brick laid in cement mortar, metal brackets attached to the building construction or by other methods approved by the Owner's Representative.

3. Horizontal piping supported within 24 inch each side of the coupling joint at 10 foot intervals for 10 foot pipe lengths and at 5 foot intervals for 5 foot pipe lengths. Supports or hangers placed to maintain alignment and grade with provision made to prevent shear. Greater than 3 inch diameter pipe braced at changes of direction to prevent horizontal movement.

E. Piping systems with material not listed above, supported and protected in accordance with manufacturer's recommendations.

F. Concrete Inserts: Zinc plated steel body, malleable iron nut. MSS SP-58 Type 18.

1. Insert for Lightweight Concrete: Anvil Fig. #285, maximum loading 400 lbs.

2. Insert for Concrete: Anvil Fig. #281, maximum loading 1,000 lbs.

G. Supports:

1. For weights under 1000 lbs.: "Drill-In" inserts equal to Phillips "Red Head" "U" Channel, beam clamps or other structurally reviewed support. The factor of safety shall be at least four. Follow manufacturer's recommendations.

2. For weights above 1000 lbs.: Drill through floor slabs and provide flat flush plate welded to top of rod or provide additional "Drill-In" inserts and hangers to reduce load per hanger below 1000 lbs.

3. For metal decks: Drill hole through for hanger rods and imbed a welded plate in concrete or use Phillips "Red Head" devices designed for this application, with a safety factor of four.

H. Trapeze Hangers:

1. Hangers shall be supported with rod sized with a safety factor of four.

2. May be manufactured type "U" shaped channel, or suitable angle iron or channel.

3. Securely fasten piping to trapeze with "U" bolt or straps, dissimilar metals shall not touch, use isolation gaskets.

4. Acceptable Manufacturer: Globestrut, Kindorf, Unistrut, B-Line, or approved equal.

I. Pipe Insulation Shields:

1. Galvanized steel shields, minimum 180° arc, unless otherwise indicated. MSS SP-58 Type 40.

2. Shields for use with hangers and supports per the following schedule:

Pipe Size	Shield Length	Shield Gauge
1/2" – 3”	12”	18
4”	12”	16
5” – 6”	18”	16

2.7 PIPING ACCESSORIES

A. Escutcheon Plates: Steel or cast iron polished chrome, split hinge type with setscrew, high plates where required for extended sleeves. Chrome plated in finished areas and at plumbing fixtures.

B. Cleanout plugs, bushings, nipples, required for instruments and gauges to be brass.

2.8 SLEEVES

A. Standard Type:

1. Schedule 40 black steel pipe sleeves, two pipe sizes larger than the pipe, for structural surfaces.

2. Sheet metal sleeves for nonstructural surfaces and existing construction. Sheet metal sleeves shall be 18-gauge minimum and braced to prevent collapsing.

2.9 FIRESTOP SYSTEM FOR OPENINGS THROUGH FIRE RATED WALL FLOOR ASSEMBLIES

A. Materials for firestopping seals shall be listed by an approved independent testing laboratory for "Through-Penetration Firestop Systems". The system shall meet the standard fire test for Through-Penetration Firestop Systems designated ASTM E814.

B. Firestop system seals shall be provided at locations where piping pass through fire rated wall, floor/ceiling, or ceiling/roof assembly.

C. Minimum required fire resistant ratings of the assembly shall be maintained by the Firestop System. Installation shall conform to the manufacturer's recommendations and other requirements necessary to meet the testing laboratory's listing for the specific installation.

2.10 STACK SLEEVE

A. With flashing clamp and threaded pipe sleeve extension.

B. Design Equipment: Jay R. Smith Series 1720 with caulking recess and flashing clamp.

C. Acceptable Manufacturer: Josam, Jay R. Smith, Zurn, Wade.

2.11 PIPING MATERIALS AND SCHEDULE

A. See Exhibit P1, "Plumbing Piping Materials", at end of this Section for general plumbing piping systems.

3.0 PART 3 - EXECUTION

3.1 EQUIPMENT AND SYSTEMS

A. Install equipment and systems in accordance with provisions of each applicable Section of these Specifications, and Local/State Codes/Regulations having jurisdiction.

B. Accurately establish grade and elevation of piping before setting sleeves.

C. Install piping without springing or forcing (except where specifically called for), making proper allowance for expansion and anchoring.

D. Arrange piping at equipment with necessary offsets, unions, flanges, and valves, to allow for easy part removal and maintenance.

E. Offset piping and change elevation as required to coordinate with other Work. Avoid contact with other mechanical or electrical systems. Make changes in direction and branch connections with fittings.

F. Provide adequate means of draining and venting units, risers, circuits and systems.

G. Conceal piping unless otherwise called for. Do not install valves, unions and flanges in inaccessible locations.

H. Ream pipes after cutting and clean before installing. Cap or plug equipment and pipe openings during construction.

I. Install piping parallel with lines of building, properly spaced to provide clearance for insulation.

J. Refer to Section 220501, Excavation and Backfill, for requirements associated with buried piping.

K. Materials within a system and between systems shall be consistent. If this is not possible, install dielectric fittings.

L. Plastic pipe is prohibited in plenums and stairs. Plastic pipe shall not be installed exposed in places of assembly.

3.2 HANGERS, INSERTS AND SUPPORTS

A. Piping shall not be supported by wires, band iron, chains, or from other piping, nor by vertical expansion bolts. Support piping with individual hangers from concrete inserts, welded supports, or beam clamps of proper configuration and loading design requirements for each location; replace if not suitable. Follow manufacturer's safe loading recommendations. Suspend with rods of sufficient length for swing, using proper diameter rod for pipe size.

B. Provide additional structural steel members, having one coat rustproof paint, where required for proper support.

C. Provide oversized hangers where insulation/supports must pass between pipe and hanger.

1. Provide pipe insulation shield at all points of support for insulated piping. Center shields on all hangers and supports outside of insulation. Install shields in manner to prevent cutting or puncturing insulation jacket.

D. Provide continuous support or extra supports for plastic pipe per manufacturer's requirements.

E. Hangers, when attached to joists, shall only be placed at the top or bottom chord panel point. Only concentric type hangers are permissible; "C" type not permitted on joists.

F. Provide riser clamps for each riser at each floor.

G. Use trapeze hangers where a group of piping can be installed.

3.3 PIPE CONNECTIONS

A. No-Lead Solder Connections: Nonacid flux; clean off excess flux and solder. Solder and flux shall comply with requirements of NSF-372.

B. Threaded Connections: Clean out tapering threads, made up with pipe dope; screwed until tight connection. Pipe dope must be specifically selected for each application.

C. Dielectric Pipe Fittings: Protect fittings from excessive heat.

3.4 SLEEVES

A. Provide for pipes passing through floors, walls or ceilings. Not required for existing floors that are core-drilled, except where floor is waterproofed. Extend 1/8 inch above finished floor in finished areas. In above grade Mechanical Rooms and other areas with floor drains, use steel pipe sleeves 2 inch above floor.

B. Use steel pipe sleeves in bearing wall, structural slabs, beams and other structural surfaces, and where called for.

C. Sleeves shall be as small as practical, consistent with insulation, so as to preserve fire rating.

D. Fill abandoned sleeves with concrete.

3.5 SLEEVE PACKING

A. Seal Void Space At Sleeves As Follows:

1. Interior locations: Firmly pack with fiberglass and caulk.

2. Exterior walls above grade: Use link-seal or approved sealing element.

3. Exterior walls below grade and above basement or vault floors: Use link-seal.

4. Cored holes: Use sealing element.

5. Fire rated, partitions and floor slabs: Use fire rated sealing elements, materials and methods.

6. Waterproofed floors: Use waterproof sealing element, device or compound.

3.6 ESCUTCHEON PLATES

A. Provide polished chrome escutcheon plates for all exposed piping passing through floors, walls or ceilings, in all rooms except in Boiler, Fan and Mechanical Rooms.

3.7 TESTS

A. Refer to other Division 22 Sections for testing of Plumbing Systems.

3.8 PIPE LINE SIZING

A. Pipe sizes called for are to be maintained. Pipe size changes made only as reviewed by Owner's Representative. Where discrepancy in size occurs, the larger size shall be provided.

EXHIBIT "P1" – PLUMBING PIPING MATERIALS

(Notes at the end of schedule)

SERVICE	PIPE MATERIALS	FITTINGS	CONNECTIONS
Domestic water interior/hot, cold and circulating 3" and smaller	Type L copper	Wrought copper	No-lead solder
Sanitary and storm (buried)	Service weight cast iron soil pipe	Cast iron hub and spigot	Neoprene gasket compression type
Vent (buried)	Service weight cast iron soil pipe, or Type DWV copper	Cast iron hub and spigot, or wrought copper; drainage pattern	Neoprene gasket compression type, or no-lead solder
Sanitary, vent and storm (not buried)	Service weight cast iron soil pipe or Type DWV copper	Cast iron hub and spigot, No-hub or wrought copper; drainage pattern	Neoprene gasket compression type, no-hub neoprene gasket and stainless steel clamp assembly or no-lead solder

NOTES:

1. Provide white PVC jacketing on all exposed domestic piping located within project areas without ceilings.

END OF SECTION 220502

SECTION 220523 - GENERAL DUTY VALVES FOR PLUMBING PIPING

1.0 PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services to perform operations required for the complete installation and related Work as required in Contract Documents.

1.2 SUBMITTALS

A. All valves and accessories listed under “Part 2 – Products” of this Section.

1. Submit cut sheets, specifications and dimensioned drawings.

2. Submit compliance with ANSI/NSF-372 for valves intended to supply drinking water.

2.0 PART 2 - PRODUCTS

2.1 VALVES - GENERAL

A. Valves shall have following requirements:

1. Working pressure stamped or cast on bodies per MSS SP-25.

2. Stem packing serviceable without removing valve from line and shall be free of asbestos.

3. Valves supplying drinking water shall comply with requirements of ANSI/NSF-61 and ANSI/NSF-372.

B. Makes:

1. Check valves: Jomar, Milwaukee, Nibco, Watts.

2. Ball valves: Apollo (Conbraco), Jomar, Milwaukee, Nibco, Watts.

3. Balance valves: Bell & Gossett, Jomar, Watts, or approved equal.

4. To establish a standard of quality and identify features, certain manufacturer's numbers are given in the following paragraphs.

2.2 CHECK VALVES

A. Swing check valves:

1. 2½ inch and 3 inch: Bronze, threaded bonnet, 200 wwp. Threaded ends, Milwaukee UP509. Solder ends, Milwaukee UP1509. Provide in horizontal positions only.

2. 2 inch and smaller: Bronze, 200 wwp. Threaded ends, Nibco T-413-Y-LF. Solder ends, Nibco S-413-Y-LF. Provide in horizontal positions only.

B. Silent (Spring) check valves:

1. 2½ inch and larger: Cast iron body, bronze alloy disc, stainless steel spring, flanged, Class 125. Nibco F-910-B-LF.

2. 2 inch and smaller: Bronze body, PTFE disc, stainless steel spring and stem, 200 wwp. Threaded ends, Nibco T-480-Y-LF. Solder ends, Nibco S-480-Y-LF. Provide in vertical or horizontal position.

2.3 BALL VALVES

A. 2 inch and smaller: Lead-free brass body with hard chrome-plated lead-free brass ball and stem, full port opening, teflon seats, end entrance, 600 #WOG, 150 #WSP. Threaded ends, Watts LFFBV-3C. Solder (sweat) ends, Watts LFFBVS-3C.

1. Valve shall have separate packing nut and handle nut.

B. 2½ inch to 4 inch: Lead-free brass body with hard chrome-plated lead-free brass ball and stem, full port opening, teflon seats, end entrance, 400 #WOG, 125 #WSP. Threaded ends, Watts LFFBV-3C. Solder (sweat) ends, Watts LFFBVS-3C.

1. Valve shall have separate packing nut and handle nut.

2.4 BALANCE VALVES

A. Lead-free brass body with stainless steel ball. Body shall have 1/4" NPT tapped drain port.

B. Calibrated balance valve with provisions for connecting a portable differential pressure meter suitable as a service valve. Meter connections shall have built-in check valves. Valves shall have memory stop feature with an integral pointer to register degree of valve opening. Valve shall have internal seals.

C. Balance valves sizes shall be based upon gpm range rather than pipe size.

Balance Valve Size	GPM Range
1/2”	up to 2.5
3/4”	2.5 - 4.5
1”	4.5 - 10
1-1/4”	10 - 15
1-1/2”	15 - 30
2”	30 - 60
2-1/2”	60 - 100
3”	100 - 180

D. Design equipment: Bell & Gossett "Circuit Setter Plus", model CB-xx-LF Series; Watts Series LFCSM-61-S, or approved equal.

2.5 VALVES FOR GAUGES AND INSTRUMENTS

A. 1/4 inch size: Stainless steel body, seat and stem. Rated for 6000 psi (maximum) and 200 Deg. F (maximum). Trerice 735 Series needle valve.

2.6 HOSE THREAD DRAIN VALVES

A. Lead-free copper silicon alloy body with 2-piece full port brass ball valve. Female NPT x 3/4 inch hose end, brass cap with polypropylene tether chain, 600 #WOG. Watts LFFBVS-3C-CC.

3.0 PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Provide valves of type called for and where required to service equipment and fixtures.

2. Use extreme care and caution when soldering valve connections to piping to prevent valve seat damage. Apply heat with the flame directed away from the center of the valve body. Inspect all valves after soldering, tighten valve packing nut and make adjustments if required to ensure valve operates properly. Replace all damaged valves.

3. Provide valves at major building and system sections, and where shown on Contract Drawings.

4. Provide extended stem on insulated valves so valve handle is outside of insulation.

5. Locate valves with stems at, or above, horizontal positions and swing check valves in horizontal position only.

6. Ball valves shall be used for water service through 4 inch, unless otherwise noted.

7. Install balance valves as recommended by the manufacturer; provide recommended pipe diameter clearance upstream and downstream from each balance valve provided.

8. Provide hose threaded drain valves at all low points, strainers, equipment, and as called for.

END OF SECTION 220523

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

1.0 PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services as required for the complete installation designed in Contract Documents.

1.2 QUALIFICATIONS

A. All identification devices shall comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles.

1.3 SUBMITTALS

A. Submit product data for each identification material and device, and for all items specified under “Part 2 - Products” of this Section.

B. Submit valve schedule for all piping systems typewritten on 8 1/2 inch x 11 inch paper, indicating code number, location and valve function. Submit with O&M Manuals.

C. Submit schedule of piping, equipment and valve identification for review before labeling. Confirm naming/numbering is consistent with Owner’s naming/numbering convention prior to labeling.

1.4 ACCEPTABLE MANUFACTURERS

A. Brady Co., Brimar Industries, Craftmark, Seton, or approved equal.

2.0 PART 2 - PRODUCTS

2.1 GENERAL

A. Provide manufacturer's products of categories and types required for each application.

2.2 PIPING IDENTIFICATION

A. Pipe Labels (Inside buildings):

1. Piping/Insulation with outside diameter of 5-7/8 inches and less: Provide acrylic plastic wrap-around type markers with directional flow arrows, UV resistance and legend printed four (4) times for 360° visibility. Make: Seton “Setmark” snap-on wrap around type pipe markers.

2. Piping/Insulation with outside diameter of 6 inches and greater: Provide acrylic plastic strap-on type markers with directional flow arrows, UV resistance and legend printed two (2) times minimum. Make: Seton “Setmark” strap-on wrap around type pipe markers.

B. Pipe labels shall conform to the following identification table:

PIPE SERVICE	IDENTIFICATION/LABEL
Domestic Cold Water	DOMESTIC COLD WATER
105°F, 110°F, or 120°F Domestic Hot Water	DOMESTIC HOT WATER
140°F Domestic Hot Water	140 DOMESTIC HOT WATER
105°F, 110°F, or 120°F Domestic Hot Water Re-circulation	DOMESTIC HOT WATER RETURN
140°F Domestic Hot Water Re-circulation	140 DOMESTIC HOT WATER RETURN
Sanitary and / or Waste	SANITARY DRAIN
Plumbing Vent	SANITARY VENT
Storm	STORM DRAIN

C. Underground Pipe Identification and Detection Marking:

1. Provide Metallic Detection Tape for all underground storm and sanitary sewers, natural gas lines and water piping. Provide 2” wide tape, 0.035”. Make: Seton style 37000 series 2 inch tape for burial 4 inches to 6 inches below surface, style 37000 series 6 inch tape for burial deeper than 6 inches.

2.3 VALVE IDENTIFICATION

A. Valve Tags:

1. Standard brass valve tags, 2" diameter with 1/2" high numerals. Identify all plumbing services with 1/4" letters above the valve number (“PLBG.”). Attach to valves using brass “jack” chain and brass “S” hook. Make: Seton Style No. M4507 tags, Style No. 16182 chain and Style No. 16195, 6 and 7 No. hooks.

B. Valve Chart:

1. Provide valve chart for all valves provided as a part of this project. Frame and place under clear glass. Hang in Mechanical Room or in location as directed by the Owner.

3.0 PART 3 - EXECUTION

3.1 GENERAL

A. Provide valve tags for all valves provided on project. Provide a valve tag chart for all valves provided on the project.

B. Provide piping identification with directional flow arrows for all piping provided on project.

1. Provide labels on straight runs of piping at 20’-0” intervals, minimum.

2. Provide labels where piping enters and leaves a partition, wall, floor or ceiling.

3. Adhesive type or stenciled labeling is unacceptable. Provide wrap-around type labels only.

C. Underground pipe detection tape:

1. Bury detection tape approximately 12 inches directly above the pipe and at least 6 inches below grade to mark the location of the buried pipe.

END OF SECTION 220553

SECTION 220700 - PLUMBING INSULATION

1.0 PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services to perform operations required for the complete installation and related Work as required in Contract Documents.

B. Plumbing insulation shall comply with the requirements of the 2020 Energy Conservation Construction Code (ECCCNYS).

1.2 SUBMITTALS

A. All items listed under “Part 2 – Products” of this Section.

1. Submit manufacturer’s data sheets.

B. Schedule of all insulation applications for this project.

2.0 PART 2 - PRODUCTS

2.1 GENERAL

A. Insulation, Jackets, Adhesives, And Coatings, Shall Comply With The Following:

1. Treatment of jackets or facings for flame and smoke safety must be permanent. Water soluble treatments not permitted.

2. Insulation, including finishes and adhesives on the exterior surfaces of pipes, and equipment, shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less; as tested by ASTM E84 (NFPA 255) and UL 723 methods.

3. Asbestos or asbestos bearing materials are prohibited.

2.2 PIPE INSULATION (RIGID TYPE)

A. Preformed rigid sectional pipe covering, 4 lb. nominal density fiberglass; ASTM C547, Class 1. White Kraft outer surface bonded to aluminum foil and reinforced with fiberglass yarn.

B. Maximum thermal conductivity (k), in units of Btu/sq. ft. hr. ^{o}F/in.:

Fluid Operating Temperature	Max. Thermal Conductivity	Mean Rating Temperature
40° F - 60° F	0.27	75° F
105° F - 140° F	0.28	100° F
Greater than 140° F	0.29	125° F

2.3 PLASTIC JACKETING

A. PVC jacket, UV-resistant, 20 mill thickness; ASTM D1784, Class 14253-C. Solvent adhesive welded joints.

2.4 MAKE

A. Fiberglass: Certainteed, Knauf, Johns Manville, Owens-Corning, or approved equal.

B. Adhesives: Childers, Foster Products, Tremco; numbers designate quality of adhesive.

2.5 MATERIALS AND SCHEDULES

A. See Exhibits at the end of this section.

3.0 PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Provide Thermal Insulation:

1. Insulation is required on piping unless otherwise called for.

2. Install insulation only on clean, dry surfaces and after work has been tested.

3. Install insulation on cold surfaces with continuous unbroken vapor seal.

4. Exposed surfaces shall be white.

5. Pipes shall be individually insulated.

B. Do not cover inspection stampings, openings, petcocks, handholes, manholes, access doors, plugged outlets, air vents, plugged openings or petcocks.

C. Install insulation, accessories, coverings and jackets in accordance with manufacturer's installation instructions.

3.2 PIPE INSULATION

A. Insulate piping systems including fittings, valves, flanges, unions, strainers, and other attachments installed in piping system, whether exposed or concealed.

B. Piping In Exterior Walls, Spaces, Overhangs, Attics, and Or Where Subject To Freezing: Insulate pipe with double the thickness called for.

1. Piping In Wall Chases: In addition to the above, pack chase with loose glass fiber insulation.

C. Plumbing Equipment:

1. Install insulation on exposed hot and cold plumbing piping.

2. Insulation is not required on valves, strainers and threaded piping, 1 inch and smaller.

3. Provide exposed domestic hot water and waste piping for plumbing fixtures designated for use by the handicapped with coverings to protect against contact. Refer to Section 224200, Commercial Plumbing Fixtures, for additional information.

D. Joints In Section Pipe Covering Made As Follows:

1. Standard: Longitudinal laps and butt joint sealing strips cemented with Foster 85-20 or factory applied pressure sensitive adhesive lap seal. Stapled with outward clinching staples.

2. Vapor barrier: For cold services, Longitudinal laps and 4 inch vapor barrier strip at butt joints shall be sealed with white Foster 85-20. Seal ends of pipe insulation at valves, flanges, and fittings with white Foster 85-20.

E. Pipe Insulation Shields:

1. Refer to Section 220502, Plumbing Piping Systems and Accessories, for requirements.

2. Provide pipe insulation shield at all points of support for insulated piping. Center shields on all hangers and supports outside of insulation. Install shields in manner to prevent cutting or puncturing insulation jacket.

F. Fittings, Valves And Flanges:

1. Hot and cold water:

a. Concealed: Insulating cement of the same thickness as adjacent pipe insulation. Cold water to be vapor sealed with Foster 30-36 "Seal-Fas".

b. Exposed: Premolded fitting covers of the same material and thickness as the adjacent pipe insulation and finished with glass cloth applied and coated with Foster 30-36 "Seal-Fas."

2. Optional: In lieu of the standard method above, the Contractor has the option of using Zeston, Ceel-Co, or Proto. Tape all joints at covers.

a. Fitting covers shall have fiberglass insulation inserts from the factory. Insulation inserts shall have 1.5 pcf minimum density; ASTM C553, Type III.

b. PVC fitting covers shall be UV-resistant.

3.3 RECOVERING

A. Field apply 6 oz. white glass cloth, cemented and applied over standard jacket. Properly cut at fittings to avoid wrinkles and coat with Foster 30-36. Leave ready for painting. Provide as called for.

3.4 EXISTING INSULATION

A. Patch existing insulation damaged during the course of the work.

3.5 EXISTING WORK

A. Insulate existing piping and equipment as called for on the Contract Drawings. Insulation material and thickness shall comply with Exhibits in this Section.

EXHIBIT "I" - PIPE INSULATION MATERIALS

SERVICE	INSULATION MATERIAL	PIPE SIZE	INSULATION THICKNESS	REMARKS
Domestic cold water	Glass fiber	1-1/2" and larger 1-1/4" and smaller	1" 1/2"	
Domestic hot water (up to 140°)	Glass fiber	1-1/2" and larger 1-1/4" and smaller	1-1/2" 1"	
Domestic hot water return (up to 140°)	Glass fiber	1-1/2" and larger 1-1/4" and smaller	1-1/2” 1"	
Domestic hot and circulation water (over 140°)	Glass fiber	1-1/2" and larger 1-1/4" and smaller	2" 1-1/2"	
Roof conductor lines	Glass fiber	All sizes	1"	Insulate body of drain and horizontal **[and vertical]** conductor piping

END OF SECTION 220700

SECTION 220801 - DOMESTIC WATER SYSTEMS BALANCING

1.0 PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services to perform operations required for complete adjusting and balancing Work as required in Contract Documents.

1.2 SUBMITTALS

A. Provide information in report form listing items required by the Project specifications. Report shall be typed, and three copies submitted for review. Results shall be guaranteed. Contractor shall be subject to recall to site to verify report information before acceptance of the report by the Owner's Representative.

B. Report format shall consist of the following:

1. Title sheet with job name, contractor, engineer, date, balance contractor's name, address, telephone number and contact person's name and the balancing technician's name.

1.3 QUALIFICATIONS

A. Follow procedures and methods published by one or more of the following:

1. Individual manufacturer requirements and recommendations.

B. Maintain qualified person at project for system operation, trouble shooting and perform mechanical adjustments in conjunction with balancing procedure.

C. Balancing contractor shall be current member of AABC or NEBB.

1.4 GENERAL REQUIREMENTS

A. Before concealment of systems visit the job site to verify and advise on type and location of balancing devices and test points. Make changes as required to balancing facilities.

B. Place systems in satisfactory operating condition.

1. Adjusting and balancing shall be accomplished as soon as the systems are complete and before Owner takes possession.

2. Prior to balancing, adjust balancing devices for full flow; fill, vent and clean plumbing systems. Replace temporary strainers.

3. Initial adjustment and balancing to quantities as called for, or as directed by the Engineer, to satisfy job conditions.

2.0 PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Provide tools, ladders, recording meters, gauges, thermometers, velometers, anemometers, inclined gauge manometers, magnehelic gauges, amprobes, voltmeters, and tachometers required. Instruments used shall be accurately calibrated as per AABC or NEBB requirements.

3.0 PART 3 - EXECUTION

3.1 PREPARATION

A. Examine Bid Documents and notify Owner's Representative of any questions regarding balancing, within thirty days after receipt of bid and prior to starting work.

3.2 WATER SIDE

A. Test, adjust and record the following:

1. Domestic Hot Water Re-circulation System Balancing Valves:

a. Balance every valve to GPM noted on the Drawings.

END OF SECTION 220801

SECTION 221100 - FACILITY WATER DISTRIBUTION

1.0 PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services to perform operations required for the complete installation and related Work as required in Contract Documents.

1.2 QUALITY ASSURANCE

A. Follow all requirements, recommendations and appendices of the following publications, codes, standards, and listings:

1. New York State Health Department: Cross Connection Control Manual.

2. 2020 Plumbing Code of New York State (PCNYS).

3. ANSI/NSF-61, Drinking Water System Components – Health Effects.

4. ANSI/NSF-372, Drinking Water System Components – Lead Content.

1.3 SUBMITTALS

A. All items specified under “Part 2 - Products” of this Section.

1. Backflow Preventers: Include pressure drop curves, dimensions, FCCCHR approvals.

B. Written certification for domestic water system tests. Submit with O&M Manuals.

C. Lab results from lead testing. Submit results to Owner, Owner’s Representative and Engineer.

2.0 PART 2 - PRODUCTS

2.1 DOMESTIC WATER SYSTEMS PIPING

A. Refer to Section 220502, “Plumbing Piping Systems and Accessories” for piping materials.

2.2 BACKFLOW PREVENTERS

A. General:

1. Backflow preventers shall be on the current edition of the List of Approved Backflow Prevention Assemblies generated by USC Foundation for Cross-Connection Control and Hydraulic Research (FCCCHR).

2. Backflow preventers shall comply with requirements of NSF-372.

3. All devices shall have stainless steel nuts and bolts and stainless steel internal parts.

4. Backflow preventers shall be easily removed from line for service; flanges or unions on each side of device.

5. Backflow preventers shall have four lead-free test cocks, strainer and resilient seated isolation valves. Provide one test cock on the inlet side of the upstream valve.

6. By-passes around backflow preventers are prohibited.

7. Acceptable manufacturers: Conbraco, Watts, Wilkins/Zurn, or approved equal.

B. Reduced pressure zone (RPZ) type:

1. Relief air shall not enter the same opening in the device as the relief water discharge.

2. Provide drain assembly from each device with air gap fitting, and full size indirect waste line to the nearest floor drain or to the exterior.

3. Provide Type D shock absorber on outlet side of device (refer to Section 223000).

4. Sizes 1/2 inch through 2 inches:

a. Lead-free cast copper silicon alloy, or lead-free bronze body.

b. Quarter-turn ball valves, lead free.

c. Bronze strainer, lead-free.

d. Make: Watts LF009-S-QT Series.

3.0 PART 3 - EXECUTION

3.1 GENERAL

A. Installation shall conform to Article 1.2 of this section and shall be provided in a workmanlike manner as determined by the Owner's Representative and the Contract Specifications.

3.2 BACKFLOW PREVENTERS

A. Install backflow preventers in accordance with manufacturer’s installation requirements, and in accordance with written requirements by the New York State Department of Health.

B. Provide supports for backflow preventers; do not support device from adjacent piping.

3.3 PIPING

A. Run all water piping slightly off level to low points. Provide drain valves and caps at all low points in the domestic water system.

B. Provide water hammer arrestors where shown or specified. Provide water hammer arrestors where solenoid or quick closing valves are installed. Refer to Section 223000, “Plumbing Equipment”.

C. Branch headers serving flush valves and fixtures shall be run full size to the last fixture being served unless otherwise noted.

D. All exposed water piping in kitchens shall be chrome plated brass from insulation to fixture or equipment connection.

E. All exposed water piping under fixtures shall be chrome plated brass.

F. Provide dielectric pipe fittings when connecting systems of dissimilar metals. Refer to Section 220502, “Plumbing Piping Systems and Accessories”.

G. Supply piping to all fixtures, faucets, shower accessories, hydrants and flush valves shall be anchored to prevent movement. Provide additional structural members and supports as required.

3.4 ASBESTOS PIPE

A. General: Existing water main piping and/or pipe insulation may contain asbestos. Cutting, drilling or other disturbance of this material shall be conducted as specified by New York State Department of Labor, Industrial Code Rule No. 56 "Asbestos". The methods and procedures specified in New York State Department of Labor, Industrial Code Rule 56 shall constitute minimum measures and shall in no way relieve the Contractor of sole responsibility for the means, methods, techniques, sequences or safety measures taken in connection with the work.

3.5 STERILIZATION

A. Provide sterilization of water piping in accordance with all requirements of the New York State Health Department, Public Water Supply Guides, Division of Sanitary Engineering, Bureau of Public Water Supply.

3.6 TESTS AND FLUSHING

A. Provide all necessary items to complete proper testing of all domestic water piping. Isolate existing systems as required.

B. Flush all water piping to remove debris, sediment, dirt, rust, corrosion and other foreign material. Flush all piping before connecting to fixture faucet and flush valves. Refer to Section 224200, “Commercial Plumbing Fixtures”. Utilize open pipe ends wherever possible.

C. Piping Supplying Domestic Water: Test at 125 psi hydrostatic pressure for two hours. All tests shall be witnessed by Engineer or Owner's Representative.

D. For all Exterior Piping:

1. Joints in pipelines shall not be covered with backfill until after successful completion of leakage tests and observance of the tests by the Engineer or the Owner's Representative.

E. A successful air test is not acceptable as the final test; however, the Division 22 contractor shall provide interim air testing of piping as construction progresses.

F. Make all leaks tight. No caulking of leaks shall be permitted. Remove and replace all defective fittings, piping and connections.

G. Collect bacteriological test samples after testing and flushing is complete. A minimum of two (2) samples shall be taken. Locations of samples shall be designated by the Owner's Representative. Collect samples in sterile bottles and send to NYS DOH approved laboratory for analysis.

1. Submit sample test results to Owner's Representative.

2. Contractor shall disinfect, flush and re-test domestic water piping until sample test results are satisfactory.

H. Required lead testing shall be provided by the School District. Lead testing shall be in accordance with the requirements outlined in the New York State Department of Health Regulation 10CRR-NY, Subpart 67-4, Lead Testing in School Drinking Water.

I. Pay all costs of tests. Perform all tests in a safe manner. Remove all discharged water resulting from testing procedures.

J. Certify in writing that all required domestic water tests have been conducted and successfully completed. Submit all certifications to the Owner's Representative.

K. Test all backflow preventers provided on project.

END OF SECTION 221100

SECTION 221301 - FACILITY WASTE WATER SYSTEMS

1.0 PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services to perform operations required for the complete installation and related Work as required in Contract Documents.

1.2 RELATED WORK

A. Basic Plumbing Requirements.

B. Excavation and Backfill.

C. Plumbing Piping Systems and Accessories.

D. Identification for Plumbing Piping and Equipment.

E. Plumbing Equipment.

1.3 SUBMITTALS

A. All items specified under “Part 2 - Products” of this Section.

B. Shop drawings for precast concrete interceptors. Shop drawings shall show all dimensions, inlet and outlet piping connections, access covers and risers, and water-tight joint details.

C. Submit written certification for sanitary, storm and vent piping system tests. Submit with O&M Manuals.

2.0 PART 2 - PRODUCTS

2.1 PLUMBING DRAINAGE SYSTEM

A. Refer to Section 220502, Plumbing Piping Systems and Accessories, for piping materials.

3.0 PART 3 – EXECUTION

3.1 GENERAL

A. Prior to commencing work, the Contractor shall verify all inverts and locations. Any discrepancy between the plans and field conditions shall be reported in writing to the Owner’s Representative and Engineer within three (3) days of discovery. No work shall start until all discrepancies have been resolved. All costs related to Contractor's failure to verify and/or report discrepancies or problems will be borne by the Contractor.

3.2 EQUIPMENT CONNECTIONS

A. Plumbing Contractor Shall:

1. Provide all roughing, and final waste and vent connections to equipment requiring same as called for by the Contract Documents.

2. Refer to the Contract Documents for roughing schedules, equipment and lists indicating scope of connections required.

3. Provide adapters and all necessary piping, fittings and connections from roughing point to equipment.

4. Install controls and devices furnished by others as noted on the Construction Documents.

3.3 FLASHING

A. For all Roof Drains (RD), Vents Through Roof (VTR) & Floor Drains (FD):

1. Cooperate closely with the General or Construction Contractor (GC or CC).

2. Division 22 Contractor responsible for tightness.

3. Roof drains: Provide with sump receiver, held by clamping ring; set slightly lower than roof to insure being at low point.

4. Vent piping: Extend vent a minimum of 24 inches above top of roof membrane or ballast, or as shown.

a. Single Ply Roofs: Provide elastomeric cone with stainless steel clamp of same manufacturer as single ply membrane.

5. Floor Drains:

a. Secure waterproof membrane to clamping ring or flange.

b. Coordinate location of drains with room layout. Refer to Contract Drawings.

c. Coordinate location of toilet room floor drains with partition layout.

d. Coordinate location of drains for equipment with locations of pads, equipment and machinery.

3.4 INTERIOR PIPING INSTALLATION

A. Minimum Pitch:

1. Piping 3 inches and smaller: 1/4 inch per foot.

2. Piping 4 inches and larger: 1/8 inch per foot.

B. Paint exposed waste and vent piping 2 inches and over with chromium paint.

C. Buried Piping:

1. Inspect piping before installation to detect apparent defects. Remove all defective piping from the site.

2. Lay piping beginning at low point of system, true to grades and alignment indicated, with unbroken continuity of invert.

3. Install gaskets in accordance with manufacturer's recommendations for use of lubricants, cements, and other special installation requirements.

4. Clean interior of piping of dirt and other superfluous material as work progresses.

a. Place temporary plugs in the ends of all pipes at end of each workday or whenever work stops.

3.5 ASBESTOS PIPE

A. General: Existing sewer main piping may contain asbestos. Cutting, drilling or other disturbance of this material shall be conducted as specified by New York State Department of Labor, Industrial Code Rule No. 56 "Asbestos". The methods and procedures specified in New York State Department of Labor, Industrial Code Rule No. 56 shall constitute minimum measures and shall in no way relieve the Contractor of sole responsibility for the means, methods, techniques, sequences or safety measures taken in connection with the work.

3.6 TESTING

A. General: Provide all necessary items to complete proper testing of Work. Isolate existing systems as required.

1. Pay all costs of test. Perform all tests in a safe manner. Remove all discharged water resulting from testing procedures.

2. Provide written certification that tests have been conducted and successfully completed. Submit to Owner's Representative.

B. Pipe testing:

1. Test all sections of storm, sanitary, waste and vent piping installed by this Project. Test existing piping as called for.

2. Maintain 10 feet head of water above highest point of section being tested for a minimum of two hours, or until all joints are inspected and proved tight.

3. For interior piping, leaks of any volume detected in sewers or in floors or walls of appurtenant structures shall be permanently stopped. Should any leaks, defective joints or defective construction be found they shall be promptly made good. Should any defective pipes or specials be discovered they shall be removed and replaced with sound pipes or specials in a satisfactory manner at the Contractor's expense.

4. Air test not acceptable as final test.

END OF SECTION 221301

SECTION 223000 - PLUMBING EQUIPMENT

1.0 PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services to perform operations required for the complete installation and related Work as required in Contract Documents.

1.2 SUBMITTALS

A. Submit shop drawings for all items specified under “Part 2 - Products” of this Section.

B. Submit written certifications for emergency safety shower and emergency eyewash tests; include in O&M Manuals.

2.0 PART 2 - PRODUCTS

2.1 FLOOR DRAINS (FD)

A. Type FD-A:

1. Coated cast iron body with bottom outlet, vandal-proof secured 6x6 inch square strainer composed of polished nickel bronze, flashing clamp and collar and drain weepholes. Verify type of outlet required on a per location basis before ordering drains. Make: Zurn Model ZN-415-6S-VP.

2. Barrier-type floor drain trap seal: Protection device shall conform to ASSE 1072. Make: RectorSeal “SureSeal” series, or approved equal.

B. Acceptable floor drain manufacturers: Jay R. Smith, Josam, Mifab, Wade, Watts and Zurn. All floor drains shall be of one manufacturer.

2.2 ROOF DRAINS (RD)

A. Type RD-A:

1. Coated cast iron body with bottom outlet, combination membrane flashing clamp ring and V-notched gravel guard, low silhouette aluminum vandal-proof locking dome, under-deck clamp and sump receiver. Verify type of outlet required on a per location basis before ordering drains. Make: Zurn Model ZA-100-C-R-VP.

B. Type RD-B:

1. Coated cast iron bodies with bottom outlet, combination membrane flashing clamp ring and V-notched gravel guard, low silhouette aluminum vandal-proof locking dome, under-deck clamp and sump receiver. Secondary drain body shall include 2” high stand pipe. Verify type of outlet required on a per location basis before ordering drains. Make: Zurn Model ZA-163 -VP.

C. Acceptable roof drain manufacturers: Jay R. Smith, Josam, Mifab, Wade, Watts and Zurn. All roof drains shall be of one manufacturer.

D. Vertical Expansion Joints:

1. Coated cast iron body with polished bronze sleeve, silicone bronze sleeve, pre-formed neoprene packing gasket, packing gland and bolted pressure ring. Verify type of inlet and outlet on a per location basis before ordering expansion joints. Make: Zurn Model ZRB-190.

2. Acceptable Expansion Joint manufacturers: Jay R. Smith, Josam, Mifab, Wade, Watts and Zurn. All expansion joints shall be of one manufacturer.

2.3 CLEANOUTS (CO, WPCO, DPCO)

A. Deck Plate Cleanout (DPCO) - floors: Coated cast iron body with 5" x 5" square scoriated and polished nickel bronze top, vandal-proof feature, adjustable leveling feature, bronze plug, tile cover as required, and anchor flange with clamp collar. All connections and fittings to be gas and water tight. Make: Zurn Model ZN1400-T-BP-KC-VP.

B. Wall Plate Cleanout (WPCO) - walls: Coated cast iron ferrule with bronze plug, 7" x 7" square stainless steel smooth access cover on nickel-bronze frame, vandal-proof screws.

1. Horizontal: Zurn Model Z1440-BP with Zurn Model ZANB1460-7-VP.

2. Vertical (cast-iron cleanout tee): Zurn Model Z1445-BP with Zurn Model ZANB1460-7-VP.

C. Acceptable cleanout manufacturers: Jay R. Smith, Josam, Wade or Zurn.

2.4 WALL HYDRANTS (WH)

A. Hydrants shall be approved by ASSE Standard 1019-B and be listed by IAPMO.

B. Hydrants shall be a 3/4 inch male hose thread, non-freeze type with automatic draining, stainless steel housing with polished nickel bronze face, integral vacuum breaker, loose key control, and adjustable wall clamp. Make: Zurn model Z1320XL-NB-WC.

1. Hydrants shall be compliant with ANSI/NSF-372.

C. Acceptable wall hydrant manufacturers: Zurn, Josam, or approved equal.

2.5 HOSE BIBBS - INTERIOR (HB)

A. Type HB: Recessed hose bibb, 3/4 inch male hose thread, polished chrome plated with removable wheel handle and vacuum breaker. Hose bibb for moderate climate. Hose bibb provided with the following:

1. Recessed wall box with wall flange, 18 gauge Type 304 stainless steel with satin exterior finish. Wall flange shall be 16 gauge stainless steel, satin finish.

2. Hose bibb valve shall be cartridge operated with vandal-resistant lock-shield and screwdriver operated stop.

3. Door for wall box shall be 16 gauge stainless steel with satin finish, removable hinge and cylinder lock. Turn keys over to Owner.

4. Make: Acorn model 8151, Jay R. Smith model 5518, Zurn model Z1350-EZ.

2.6 WATER HAMMER ARRESTORS / SHOCK ABSORBERS (SA)

A. Devices must meet or exceed requirements of the Plumbing and Drainage Institute Standard PDI - WH 201 and ASSE Standard 1010.

B. Types of devices listed by the Contract Documents shall be based on the P.D.I. system corresponding to the following N.Y.S. water fixture unit ranges:

1. Type A - 1 through 11 fixture units.

2. Type B - 12 through 32 fixture units.

3. Type C - 33 through 60 fixture units.

4. Type D - 61 through 113 fixture units.

5. Type E - 114 through 154 fixture units.

6. Type F - 155 through 330 fixture units.

C. All stainless steel construction, casing and bellows; male IPS inlet. Make: Zurn "Shoktrol", Z-1700 Series.

D. Acceptable Water Hammer Arrestor / Shock Absorber manufacturers: Jay R. Smith, Josam, Precision Plumbing Products, Wade or Zurn.

2.7 THERMOMETERS - DOMESTIC WATER (T)

A. Adjustable multi-angle type, 9" scale size, 3-1/2 inch stem length, brass well, scale calibrated in 2° divisions from 30° F to 240° F for domestic hot water, 0° F to 120° F for domestic cold water. Make: Weksler Thermometer Cat. No. AS5H-9.

B. Acceptable thermometer manufacturers: American, Ashcroft, Weiss or Weksler.

2.8 TEMPERATURE MIXING VALVE

A. Control Valve Mixing 140°F hot water with 40°F cold water to obtain a tempered outlet temperature of 105°F, with cold water bypass. Mixing valve shall be pressure independent hi/lo thermostatic mixing valve. Provide valve with the following:

1. Mixing valve with 1 1/4 inch inlets and 1 1/2 inch outlet. Rated for flow of 68 gpm at 10 psi pressure drop.

2. Combination strainer check stops with union inlet.

3. Two volume control/shutoff valves, horizontal stem dial thermometer, fittings, nipples and escutcheon plates.

4. Chrome plated mixing valve and trim.

B. Mixing valve shall be lead-free and ASSE 1017 compliant.

C. Make: Powers Series LFMM434, Symmons, or approved equal.

3.0 PART 3 - EXECUTION

3.1 EQUIPMENT CONNECTIONS

A. Plumbing Contractor Shall:

1. Provide all roughing and final water, waste and/or vent connections to all fixtures and equipment requiring same as called for by the Contract Documents.

2. Refer to the Contract Documents for roughing schedules, equipment and lists indicating scope of connections required.

3. Provide loose key stops, P-traps, tailpieces, adapters and all necessary piping, fittings and connections from roughing point to fixtures and equipment.

4. Provide for installation of sinks, faucets, outlets, traps, tailpieces, etc. furnished by an Equipment or Casework Contractor. These items shall be delivered in easily identified cartons, to the proper room for the Division 22 Contractor's installation.

5. Install controls and devices furnished by others as noted on the Construction Documents.

6. Provide cold water line with reduced pressure zone backflow prevention devices at locations noted on the Construction Documents. Continuation of piping downstream from devices by others when noted.

7. Provide relief valve discharge piping from equipment relief valves to floor drains, mop service sinks or exterior.

3.2 FLOOR DRAINS

A. Install floor drains where shown on the Contract Drawings. Install in accordance with manufacturer’s written instructions.

B. Connect floor drain to sanitary waste piping. Connect waterproofing membrane, where furnished, to flashing clamp.

C. Level strainer with final floor finish. Clean strainer holes of all construction debris.

D. Maintain floor drain body clean of debris during construction.

3.3 ROOF DRAINS

A. Install roof drains where shown on the Contract Drawings. Install in accordance with manufacturer's written instructions.

B. Connect roof drain to storm piping. Connect roofing membrane to flashing clamp.

3.4 EXPANSION JOINTS FOR ROOF DRAINS

A. Provide expansion joints for all roof drains located more than 25 feet - 0 inches above the finished floor of area being served.

3.5 CLEANOUTS

A. Install cleanouts out of traffic patterns; provide offset as required from sanitary line being served. Do not locate cleanouts under doors or under lockers.

B. Install cleanouts in accordance with manufacturer's written instructions.

C. Distance between cleanouts:

1. Piping 4 inches and smaller: 50 feet.

2. Piping 5 inches and larger: 100 feet.

D. Provide cleanouts at all changes in direction of piping greater than 45°. Provide cleanouts at base of soil, waste, and vent stacks, and roof conductors. Provide additional cleanouts where shown on the Contract Drawings.

E. Cleanouts: Same nominal size as pipe, but not larger than 4 inches.

3.6 WALL HYDRANTS

A. Provide wall hydrants where shown on the Contract Drawings at a minimum of 24 inches above grade.

B. Install wall hydrants in accordance with manufacturer's installation instructions.

3.7 HOSE BIBBS

A. Provide hose bibbs at low points of piping systems.

B. Provide hose bibbs where shown on Contract Drawings. Mount at a minimum of 18 inches above finished floor.

3.8 SHOCK ABSORBERS

A. Provide shock absorbers in the vertical position.

B. Provide a ball valve between each shock absorber and the line being served.

C. Provide shock absorbers where shown or specified. Provide shock absorbers where solenoid valves or quick closing valves are installed.

3.9 THERMOMETERS

A. Provide where called for and where shown. Adjust each thermometer so face is easily visible.

3.10 TEMPERATURE MIXING VALVE

A. Provide temperature mixing valve where shown on Contract Drawings. Install mixing valve in accordance with manufacturer's written instructions.

B. Provide 2 foot deep heat trap on hot water supply pipe ahead of connection to mixing valve. Refer to detail on Construction Documents.

END OF SECTION 223000

SECTION 224200 - COMMERCIAL PLUMBING FIXTURES

1.0 PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide all labor, materials, equipment and services to perform operations required for the complete installation and related Work as required in Contract Documents.

B. Provide “control” wiring circuits for fixtures, trim, equipment and associated control devices. Provide wiring, conduit, boxes, accessories and related appurtenances. Control wiring includes 120 volt and lower wiring for control signals directing equipment operation. Refer to Section 220901, “Electric Wiring for Plumbing Systems”.

1.2 SUBMITTALS

A. Submit shop drawings for all items specified under “Part 2 - Products" of this Section.

1. Fixture Cuts: Submit shop drawings in folders with cuts of all fixtures, brass trim and accessories before placing order for fixtures. Provide roughing sheets for all fixtures. Provide dimensions for all fixtures, trim and accessories.

2. Samples: Submit fixture and accessory samples when requested by Owner and/or Owner’s Representative.

3. Roughing Sheets: Submit roughing sheets in duplicate for each type of fixture when requested.

4. Deliver cut out data for countertop fixtures to General Contractor.

B. Submit wiring diagrams and manufacturer’s electrical requirements for all electronically operated fixtures and trim.

C. Submit manufacturer’s color charts for cabinet finishes and fixture colors.

D. Submit operations and maintenance information for each fixture, faucet, shower and trim piece. Include this information in the Operations and Maintenance Manual specified in Section 220010.

1.3 DESCRIPTION OF FIXTURES

A. All fixtures, trim and fixture accessories shall be similar and equal to the manufacturer’s plate numbers specified in this section. All fixtures and supply trim shall meet the requirements of the New York State Department of Environmental Conservation and shall be listed by that Agency. All exposed parts of fixture trim shall have a polished chrome finish. All tubular drainage products (“P” traps, nipples, etc.) for sinks, electric water coolers, drinking fountains and lavatories shall be 17 gauge brass.

B. All fixtures, trim and fixture accessories shall comply with requirements of ANSI/NSF-61 and ANSI/NSF-372.

C. All fixtures, trim and fixture accessories shall be subject to compliance with the specified requirements and shall be manufactured by the following:

1. Water Closets and Lavatories: American Standard, Kohler, Mansfield, Sloan, Zurn.

2. Mop Service Sinks: Fiat, Mustee, Stern-Williams.

3. Faucets: Chicago, Symmons, T&S Brass.

4. Flush Valves: Delany, Sloan “Regal”, Zurn.

5. Water Closet Seats: Bemis, Beneke, Church, Olsonite, Sperzel.

6. Electric Water Coolers: Elkay, Halsey-Taylor, Haws, Oasis, Sunroc.

7. Fixture Supports and Carriers: Jay R. Smith, Josam, Wade, Zurn.

8. Lavatory and Water Cooler Trim: Brass-Craft, Cambridge, McGuire.

9. Shower Brass and Trim: Powers, Speakman, Symmons.

10. Shower Stalls: Aker, Clarion, Lasco.

11. Provide the Owner with special wrenches, tools and devices necessary for servicing plumbing fixtures and trim in a quantity of one device for each 5 (five) fixtures (provide a minimum of one device if fixture quantity is less than five). Provide the Owner with shower and faucet repair kits complete with all parts in a quantity of 1 (one) kit for each 20 (twenty) faucets and showers. Provide a minimum of (1) one kit for each faucet and shower if fixture quantity is less than (20) twenty.

2.0 PART 2 - PRODUCTS

2.1 WATER CLOSETS (WC)

A. American Standard No. 3351.101 “Afwall Millennium FloWise”, vitreous china, siphon jet, fully glazed trapway, elongated, 1.28 gallons per flush, HET, wall hung water closet with 1½ inch top spud, fitted with following:

1. Sloan Regal 111 SFSM-1.28-1-IN-STOP-T-TMO battery powered sensor operated flush valve, 1.28 gpf, with screwdriver angle stop, quiet flush equipment and vacuum breaker.

2. Church No. 9500SSCT, white solid plastic open front closet seat with combination self-sustaining and external check holds/hinges, less cover.

3. Jay R. Smith Series 0200 through 0500 closet fittings and carrier systems. Provide carrier and all required fittings and connections. Verify wall and chase space and piping requirements before ordering any items. Provide compact type carrier and fittings only if available space prohibits conventional carriers.

4. Mount at standard ADA required height.

5. Provide fixture in compliance with all standard ADA required clearances and dimensions.

2.2 LAVATORIES (LAV)

A. Type LAV-A:

1. American Standard No. 0356.421 “Lucerne”, wall hung, 20 inches x 18 inches with single center faucet hole, vitreous china front overflow lavatory with self-draining deck and punchings for concealed arm carrier, fitted with following:

a. McGuire No. 155-WC, chrome plated P.O. plug with open grid strainer and offset 1-1/4 inch, 17 gauge tailpiece.

b. McGuire No. 8902, chrome plated, 17 gauge, 1-1/4 inch x 1-1/2 inch “P" trap with cleanout plug and metal, chrome plated set screw wall escutcheon.

c. McGuire No. LFST03LK, 3/8 inch chrome plated wall supplies with loose key angle stops, plus chrome-plated cast brass set screw shallow escutcheons.

d. Jay R. Smith Series 0700 concealed arm floor mounted carrier with locking device, leveling screw and welded base.

e. Provide Truebro “Lav Guard 2” insulated coverings on waste and supply piping, (trap wrap kit).

f. Mount fixture at standard ADA required height. Provide fixture in compliance with all standard ADA required clearances and dimensions.

2.3 MOP SERVICE SINK (MSS)

A. Type MSS-A:

1. Mustee Model No. 63M, 24 inch x 24 inch x 10 inch deep, floor mounted fiberglass resin mop service sink, fitted with the following:

a. Chicago Faucet model 897-CRCF service sink faucet with vacuum breaker, pail hook, adjustable supply arms, integral check valves, integral supply stops, ceramic quarter-turn cartridge and ¾ inch hose thread outlet. Rough chrome plated finish.

b. 3 inch brass drain assembly - chrome plated brass drain body, chrome plated cast brass locknut, neoprene sealing washers, flat strainer and stainless steel screws.

c. Mustee No. 65.700 Hose and hose bracket.

d. Mustee No. 65.600 Mop hanger.

e. Mustee No. 63-401 Rigid vinyl bumper guards. Provide on all sides of sink not adjacent to walls.

2.4 ELECTRIC WATER COOLER (EWC)

A. Type EWC-A:

1. Elkay Model Number LZSTL8WSLK lead free, self-closing electric water cooler, dual unit, with refrigerated bottle filling station, each unit with one piece stainless steel basin and backsplash, flexible safety bubbler, non-pressurized tank, vandal-proof pushbars on front of each unit and mounting hangers.

a. Each Unit's Fountain Top: 18 gauge type 304 stainless steel, polished satin finish.

b. Self-closing, vandalproof, hand operated stops with automatic stream regulator located inside of cabinet.

c. Surfaces and materials in contact with water to be certified lead free per EPA regulations.

d. Refrigerated bottle filling station with electronic sensor activation and 30 second shut-off timer, "Water Sentry Plus" 3,000 gallon water filter system, 1.1 gpm fill rate.

e. Each Compressor: Hermetically sealed, 1/4 Hp, 120 volts, 60 Hz., single phase.

f. Each Unit Capacity: 8.0 GPH at 80^{o}F water inlet, 50^{o}F water outlet with room temperature at 90^{o}F.

g. Provide floor mounted carrier for fixture. Jay R. Smith Series 0834.

h. Provide trap and lead-free supply for each unit.

i. Provide fixture in compliance with all ADA requirements.

2.5 SHOWERS (SHR)

A. Type SHR-A: (For the physically challenged)

1. Refer to other Sections for shower base, walls, soap dish, curtain rod, etc. Shower shall be fitted with the following:

a. Thermostatic and pressure balancing mixing shower valve, ASSE-1016 compliant. Lever handle, hand held shower on 18 inch glide rail, flexible metal hose, in-line vacuum breaker, and 18 gauge type 304 stainless steel shroud with extension pieces.

b. Mount all hardware and controls as directed by the Architect. Provide fixture in compliance with all ADA required clearances and dimensions.

2. Make: Powers HydroPanel II shower system with e420-Series shower valve, model 4504215E.

   a. Mount shower controls on the opposite wall of the seat.

   b. Grid drain strainer: McGuire No. 1266A.

   c. Mount all hardware as directed by the Architect. Provide fixture in compliance with all ADA required clearances and dimensions.

3.0 PART 3 - EXECUTION

3.1 FIXTURES, EQUIPMENT AND SYSTEMS

A. Install fixtures, trim, accessories, equipment and systems as shown on the Drawings or as specified herein in accordance with the provisions of each applicable Section of these Specifications and in compliance with all Federal, State and Local codes having jurisdiction.

B. Provide control wiring, conduit, boxes, accessories and related appurtenances required for fixtures, trim, equipment and associated control devices. Install in accordance with manufacturer's written instructions.

1. Provide complete wiring diagrams for equipment and systems. Deliver wiring diagrams to proper parties in time for roughing of conduit, equipment connections, and avoid delay in construction schedule. Wiring diagrams and roughing information to clearly indicate items to be mounted and/or wired as part of the work of Division 26, "Electric".

2. Refer to Section 220901, "Electric Wiring for Plumbing Systems", for additional requirements.

3.2 FIXTURES

A. Install all fixtures on chair carriers except as specified. Vitreous china to be fired before and after glaze is applied (twice fired) and shall be without decoration unless otherwise noted.

B. Install fixtures, trim and accessories in accordance with manufacturer's installation instructions.

C. Chromium Plating:

1. All supply and drainage trim and accessories shall have a minimum thickness of 0.002 inch chromium applied over a nickel plating having a minimum thickness of 0.0002 inch.

D. Screws, Bolts and Nuts:

1. All screws, nuts and bolts shall be of size, type and finish to fit requirements and to harmonize with adjacent material.

2. Nut and bolt heads exposed at fixtures shall be hexagon with bonnet cap and chromium plated brass.

E. Erection:

1. Properly install fixtures and associated supply and drainage piping and securely support.

2. Carefully drill holes for thru-bolts to avoid chipping blocks or plaster where required over plates.

3. Except where chair carriers are specified, attach fixtures with hangers or brackets. Attach to walls as follows:

a. Masonry construction:

1) Secure fixture hangers to partition by thru-bolts extending through a steel plate on opposite side of partition.

2) Carefully drill holes to avoid chipping.

3) Obtain Owner's Representative's approval prior to work.

b. Metal stud construction:

1) Anchor backing for fixtures or equipment to 1/8 inch x 12 inch steel plate bolted or riveted to at least three studs.

2) Obtain Owner's Representative's approval prior to work.

F. Protection: Immediately after installation, thoroughly cover metal trimmings and fixture to prevent damage or scratches. Condition of all fixtures is the responsibility of the Division 22 contractor until the Owner takes final possession of the Project.

G. Cleaning: At completion of Work, clean all fixtures complete with their trimmings; put in working order and in first-class condition and appearance.

H. Installation:

1. Exact mounting height to be determined by Owner's Representative, Architectural Drawings and (where applicable) all ADA requirements.

2. Perimeter of fixtures in contact with wall to be caulked with DAP white flexible "Kwik-Seal" tub and tile caulk. Caulk shall be non-shrinking type.

3. Countertop sinks and lavatories: Set countertop mounted sinks and lavatories in a bed of approved setting compound, which will cover the entire perimeter of the sink or lavatory that comes in contact with the countertop.

4. Chair carriers:

   a. Anchor chair carriers to concrete floor with 1/2 inch x 3 inch anchors or thru-bolts and washers. Quantity of anchors: Water Closets – 4; Water Coolers, Lavatories and Urinals - 8. Provide for drilling of floor and installation of expansion shields.

END OF SECTION 224200

SECTION 230010 - BASIC MECHANICAL REQUIREMENTS

1.0 PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All drawings and general provisions of Contract, including all General and Supplementary Conditions, Division 1 Specification Sections, and Instructions to Bidders apply to this section and all other sections of Division 23.

B. Section 019113 - Commissioning Requirements

1.2 SCOPE OF WORK

A. All portions of the work shown in the construction documents shall be bid by the Mechanical Contractor. Responsibility for performance of subcontractors and trades as lower tier contracts, such as electrical, shall be included as part of the Mechanical Contractor's scope of work.

B. Include in bid all labor, materials, tools, plant, transportation, excavation, equipment, insurance, temporary protection, permits, taxes, services and all necessary and related items required to provide complete and operational systems shown and described.

C. References to codes and standards called for in the Contract Documents mean the latest edition, amendment and revisions to the codes and standards in effect on the date of these Contract Documents.

D. Minimum composition requirements and/or installation methods for the following materials and work are included in this section:

1. Miscellaneous Supports
2. Access Doors and Panels
3. Fire Stopping
4. Cutting and Patching

E. Contract shall include, but not be limited to:

1. HVAC
2. General Contracting work as related to the HVAC Contract
3. Temperature Controls
4. Testing and Balancing of Mechanical Systems

1.3 REGULATIONS AND CODE COMPLIANCE

A. All work and materials shall conform to and be installed, inspected and tested in accordance with the governing rules and regulations of federal, state and local governmental agencies having jurisdictional authority. In the event of conflict between these contract documents and the governing rules, regulations, and codes, the most stringent standards shall apply as directed by the Engineer and/or Authorities having jurisdiction.

B. Codes and standards that apply to this project include, but are not limited to:

1. 2020 Building Code of New York State (BCNYS)
2. 2020 Existing Building Code of New York State (EBCNYS)
3. 2020 Energy Conservation Construction Code of New York State (ECCCNYS)
4. 2020 Fire Code of New York State (FCNYS)
5. 2020 Fuel Gas Code of New York State (FGCNYS)
6. 2020 Mechanical Code of New York State (MCNYS)
7. 2020 Plumbing Code of New York State (PCNYS)
8. ASHRAE Standard 90.1-2016, Energy Standard for Buildings Except Low-Rise Residential Buildings.
9. New York State Department of Labor Rules and Regulations.
10. New York State Department of Health Regulations.
11. New York State Education Department - “Manual of Planning Standards”.
12. Federal Occupational Safety and Health Administration (OSHA) Regulations
13. Local Codes and Ordinances for Endwell, NY, Town of Union, State of New York.
14. Factory Mutual and/or Owner’s Insurance Carrier
15. New York Board of Fire Underwriters.
16. 2022 ASHRAE 15, Standard for Refrigeration Systems.

1.4 LICENSING & PERMITS

A. The Contractor shall hold a license all necessary licenses to perform the scope of work at the project location.

B. Apply for and obtain all required permits and inspections, include costs for all fees and charges within bid.

C. Refer to General Conditions of the Contract for additional requirements.

1.5 GLOSSARY

ADA	Americans with Disabilities Act
AGA	American Gas Association
AGCA	Associated General Contractors of America, Inc.
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AMCA	Air Moving and Conditioning Association
ANSI	American National Standards Institute
ARI	Air-Conditioning and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigeration and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing Materials
AWSC	American Welding Society Code
EIA	Electronic Industries Association
FCC	Federal Communications Commission
FM	Factory Mutual Insurance Company
GAP	Global Asset Protection
IEEE	Institute of Electrical and Electronics Engineers
IRI	Industrial Risk Insurers
ISO	International Standards Organization
NEC	National Electrical Code
NEMA	National Electrical Manufacturers' Association
NESC	National Electrical Safety Code
NFPA	National Fire Protection Association
NYS/DEC	New York State Department of Environmental Conservation
NYS/UFBC	New York State Uniform Fire Prevention and Building Code
OSHA	Occupational Safety and Health Administration
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
UL	Underwriter's Laboratories, Inc.

1.6 DEFINITIONS

Approved / Approval	Written permission to use a material or system.
As Called For	Materials, equipment including the execution specified/shown in the contract documents.
Code Requirements	Minimum requirements.
Concealed	Work installed in pipe and duct shafts, chases or recesses, inside walls, above ceilings, in slabs or below grade.
Design Equipment	Refer to the article, BASIS OF DESIGN
Design Make	Refer to the article, BASIS OF DESIGN.
Equal or Equivalent	Equally acceptable as determined by Owner’s Representative
Exposed	Work not identified as concealed.
Final Acceptance	Owner acceptance of the project from Contractor upon certification by Owner's Representative.
Furnish	Supply and deliver to installation location.
Furnished by Others	Receive delivery at job site or where called for and install.

Inspection	Visual observations by Owner's Site Representative.
Install	Mount and connect equipment and associated materials ready for use.
Labeled	Refers to classification by a standards agency.
Make	Refer to the article, BASIS OF DESIGN.
Or Approved Equal	Approved equal or equivalent as determined by Owner's Representative.
Owner's Representative	The Prime Professional, Construction Management, or other entity contractually authorized by the Owner for the services referenced.
Prime Professional	Architect / Architectural Entity or Engineer / Engineering Entity having a contract directly with the Owner for professional services.
Professional Engineer	Individual or Entity licensed to perform Engineering services in the State of New York
Provide	Furnish, install and connect ready for use.
Relocate	Disassemble, disconnect, and transport equipment to new locations, then clean, test, and install ready for use
Replace	Remove and provide new item.
Review	A general contractual conformance check of specified products.
Roughing	Pipe, duct, conduit, equipment layout and installation.
Satisfactory	As specified in contract documents.
Site Representative	Construction Manager or Owner's Inspector at the work site.

Refer to General Conditions of the Contract for additional definitions.

1.7 BASIS OF DESIGN

A. The contract documents are prepared on the basis of one manufacturer as "design equipment," even though other manufacturers' names are listed as acceptable makes. If Contractor elects to use one of the listed makes other than "design equipment," submit detailed drawings, indicating proposed installation of equipment. Contractor shall make all necessary field measurements and investigations to assure that the equipment and assemblies will meet contract requirements. Show maintenance clearances, service removal space required, and other pertinent revisions to the design arrangement. Contractor shall provide changes in work of all other trades at no increase in any contract. Provide larger motors, electrical feeders, circuit breakers, equipment, additional control devices, valves, fittings and other miscellaneous equipment required for proper operation, and assumes responsibility for proper location of roughing and connections by other trades. Remove and replace door frames, access doors, walls, ceilings or floors required to install other than design make equipment. Contractor shall retain the ultimate responsibility for function of equipment and materials which are not the basis of design for the contract documents. If revised arrangement submittal is rejected, revise and resubmit specified "design equipment" item which conforms to contract documents.

1.8 INTENT OF DRAWINGS

A. The drawings are diagrammatic, unless detailed dimensioned drawings are included. Drawings show approximate locations of equipment, and fixtures. Exact locations are subject to the approval of the Owner's Representative.

B. In the event of conflict between the drawings and specifications, or discrepancies within either, this shall be brought to the attention of the Engineer for resolution prior to submission of bids. In the event that the contractor fails to note these discrepancies prior to submission of bids or in writing within their bid submission, the Engineer shall resolve the discrepancy such that the design intent is provided. The contractor shall provide all labor, materials and equipment to correct the installation deficiencies as defined by the Engineer.

1.9 ELECTRONIC CAD DRAWING FILES

A. The Engineer may provide the Contractor with AutoCAD .dwg or MicroStation 'dgn' format files for this project with the understanding that these CAD files shall be used for reference purposes only, and not as shop drawings or as-built documents. It is the Contractors' responsibility to provide detailed, coordinated shop drawings and documentation prior to installation. The purpose of the Contractors' coordination shop drawings is to account for all trades and field conditions and identify any conflicts that shall be resolved prior to installation.

B. Any additional cost for changes due to conflicts as a result of the Contractors' failure to provide properly coordinated documents will be the responsibility of the Contractors and not of the Engineer.

C. If the Contractor requests electronic CAD files from the Engineer and this request is granted, the Contractor shall submit application to the Engineer identifying each drawings to process the request.

1.10 QUALITY ASSURANCE

A. Manufacturers of equipment shall be firms regularly and currently engaged in the production of equipment and accessories provided. The design and size/capacity of each item of equipment provided for this project needs to have been in satisfactory and efficient operation on at least three (3) installations for not less than three (3) years.

B. Suppliers of equipment must have factory trained and authorized personnel for the service of all equipment provided.

C. Apply and install materials, equipment, and specialties in accordance with manufacturer's written instructions. Conflicts between the manufacturer's instructions and the contract documents shall be referred to the Owner's Representative for resolution.

D. The contractor shall engage the services of a qualified installer for the installation and application of joint sealers, flashing, access panels, cutting and patching.

E. All work shall be done in a neat and workmanlike manner. All methods of construction or details of workmanship, not specifically described or indicated in the contract documents, shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and construction indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

F. In the absence of specific information within other sections of this project manual, all work of this project shall be provided with a one year labor and materials warranty against defects in equipment, materials and workmanship, starting from the date of project substantial completion.

2.0 PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIAL MINIMUM REQUIREMENTS

A. Provide materials that meet the following minimum requirements:

1. Materials shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less, in accordance with NFPA 255.

2. All equipment and material for which there is a listing service shall bear a UL label.

3. Gas-fired equipment and systems shall meet AGA Regulations and shall have an AGA label

4. Electrical equipment and systems shall meet UL Standards and requirements of the NEC. This listing requirement applies to the entire assembly. Any modifications to equipment to suit the intent of the specifications shall be performed in accordance with UL Standards and the requirements of the NEC.

5. Communications equipment shall meet all FCC Regulations

6. All materials, unless otherwise specified, shall be new and be the standard products of the manufacturer. Used equipment or damaged material will be rejected.

7. The listing of a manufacturer as “acceptable” does not indicate acceptance of a standard or catalogued item of equipment. All equipment and systems must conform to the Specifications.

2.2 SUBSTITUTIONS

A. The materials, products and equipment described in the Bidding Documents establish a standard of required quality, functions, dimensions and appearance that must be met by any proposed substitution.

B. Proposed substitutions must be submitted in writing to the Architect and Engineer a minimum of ten (10) days prior to the date for receipt of Bids. Each request shall include the name of the proposed material, product or equipment being substituted, cut sheets, installation drawings, performance and test data, warranties and location of three (3) similar installations with reference names of owner or facility personnel responsible for maintaining equipment. At that time the equipment or will be evaluated and if determined to be acceptable an Addendum will be issued to all bidders. Failure to follow the guidelines described above may result in equipment being rejected at submittal based solely on failure to follow the above guidelines.

C. Approval by the Architect and/or Engineer to proceed with a substitution does not relieve the contractor from meeting all of the dimensional requirements and maintaining the full functionality and performance of the material, product or equipment used as the basis of design.

D. Electrical Design Changes Due to Mechanical Substitutions – It shall be the responsibility of all Contractors to transmit all changes of electrical characteristics to the Electrical Contractor which result from any substitutions PRIOR to starting any work. Any and all extra charges by the Electrical Contractor due to these changes are to be paid by the Contractor making the change.

E. Requests for substitution shall be made only by a Bidder. Requests for substitution from sales representatives, vendors or suppliers are unacceptable and will not be considered.

2.3 FACTORY-ASSEMBLED PRODUCTS

A. Provide maximum standardization of components to reduce spare part requirements.

B. Manufacturers of equipment assemblies which include components made by others shall assume complete responsibility for final assembled unit.

1. All components of an assembled unit need not be products of the same manufacturer.

2. Constituent parts which are alike shall be products of a single manufacturer.

3. Components shall be compatible with each other and with the total assembly for intended service.

4. Contractor shall guarantee performance of assemblies of components and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly.

C. Components of equipment shall bear the manufacturer's name or trademark, model number and serial number on a name plate securely affixed in a conspicuous place, or cast integral with, stamped or otherwise permanently marked upon the components of the equipment.

D. Major items of equipment which serve the same function must be the same make and model. Exception will be permitted if performance requirements cannot be met.

2.4 COMPATIBILITY OF RELATED EQUIPMENT

A. Equipment and materials installed shall be compatible in all respects with other items being furnished and with existing items so that a complete and fully operational system will result.

2.5 SPECIAL TOOLS

A. If any part of equipment requires a special tool for assembly, adjustment or maintenance thereof and such tool is not readily available in the commercial tool market, it shall be furnished by the Contractor as required for the duration of the project and turned over to the Owner in serviceable condition upon completion of the scope of work. Contractor shall obtain written sign off by the Owner certifying that the Owner is in receipt of such tools.

2.6 SAFETY GUARDS

A. Provide guards on all shafts and couplings and all V-belt and sheave assemblies to prevent damage to equipment and injury to personnel.

2.7 LIFTING ATTACHMENTS

A. Provide equipment with suitable lifting attachments to enable equipment to be lifted in its normal position. Lifting attachments shall withstand any handling conditions that might be encountered without bending or distortion of shape, such as rapid lowering and braking of load.

2.8 MISCELLANEOUS SUPPORTS

A. Metal bars, plates, tubing, etc. shall conform ASTM standards:

1. Steel plates, shapes, bars, and grating - ASTM A 36

2. Cold-Formed Steel Tubing - ASTM A 500

3. Hot - Rolled Steel Tubing - ASTM A 501

4. Steel Pipe - ASTM A 53, Schedule 40, welded

B. Metal fasteners shall be zinc-coated (type, grade and class as required).

2.9 ACCESS DOORS AND PANELS

A. Steel access doors and frames shall be factory fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush.

B. Provide access doors at all locations where equipment access for service, repair, and/or adjustment may be required. This shall include access to all air balance dampers. (In lieu of access to air balance dampers above hard ceilings or in chase walls, Contractor may submit for approval for use of remote regulators.)

C. Construction:

1. Frames:

a) 16 gage steel with 1 inch wide, exposed, perimeter flange and adjustable masonry anchors for units installed in masonry, pre-cast, cast-in-place concrete, or ceramic tile.

b) 16 gage steel, perforated flanges with bead for gypsum or plaster wall board.

c) 16 gage steel with galvanized, expanded metal lath and exposed casing bead, welded to perimeter of frame for full bed plaster applications.

2. Access Doors:

a) Provide 14 gage sheet steel, flush panel doors with concealed, continuous, factory-installed piano hinge, primed and painted, set to open 175 degrees in unrated partitions.

b) Provide fire-rated, insulated, flush panel doors, with continuous piano hinge and self-closing mechanism rated for 1-½ hour “B” labeled, in fire-rated partitions.

3. Provide flush, screwdriver operated cam locks on all access doors.

4. Access doors shall be gasketed type where installed in rooms or spaces required to maintain a positive or negative pressure requirement to adjacent rooms or spaces.

2.10 CONCRETE BASES

A. Provide concrete bases for all floor mounted equipment. Provide 3000# concrete, camfer edges, trowel finish and securely bond to floor by roughing slab and coating with cement grout. Provide a minimum of one ½” rebar dowel for every 2 sq. ft. base area, anchored 2” into floor and base to eliminate movement, minimum of 4 dowels per base. Bases shall be nominal 4” high unless otherwise indicated, shaped and size to accommodate equipment, and extend 4” beyond equipment footprint in all directions. Set equipment anchor bolts in sleeves before pouring. After anchoring and leveling, fill equipment bases with grout.

2.11 FIRE STOPPING

A. Fire-stopping for openings through fire and / or smoke rated walls and floor assemblies shall be listed or classified by an approved independent testing laboratory for "Through-Penetration Fire-Stop Systems." The system shall meet the requirements of "Fire Tests of Through-Penetration Fire-Stops" designated by ASTM E814.

B. Submit for approval all fire stop systems and materials for approval by the Engineer

C. Acceptable Manufacturers:

1. Hilti Firestop Systems

2. Dow Corning Fire-Stop System Foams and Sealants.

3. Nelson Electric Fire-Stop System Putty, CLK and WRP.

4. Thomas & Betts - S-100 FS500/600,

5. Carborundum Fyre Putty.

2.12 REFRIGERANT SYSTEMS

A. Refer to equipment schedules on the contract drawings for refrigerant type, classification and charge quantity for Basis of Design equipment. Refer to the related sections of the project manual for additional requirements.

B. For equipment which deviates from the Basis of Design equipment scheduled refrigerant type, classification or charge quantity, Contractor shall provide changes in work of all trades, including their own, necessary for meeting all ASHRAE 15 2022 requirements at no increase in any contract. This shall include the costs of additional engineering services. Refer to paragraph 3.19 of this section.

3.0 PART 3 - EXECUTION

3.1 SUBMITTALS: SHOP DRAWINGS/PRODUCT DATA/SAMPLES

A. Submit Shop Drawings on all items of equipment and materials to be furnished and installed. Submission of Shop Drawings and samples shall be accompanied by a transmittal letter, stating name of project and contractor, number of drawings, titles, and other pertinent data called for in individual sections. Shop Drawings shall be dated and contain: name of project; name of prime professional; name of prime contractor; description or names of equipment, materials and items; and complete identification of locations at which materials or equipment are to be installed. Incomplete submittals will not be accepted. All products specified in an individual Division 23 Section shall be submitted at the same time. Number each submittal. Indicate deviations from contract requirements on Letter of Transmittal. Corrections or comments made on the Shop Drawings during the review do not relieve the Contractor from compliance with requirements of the drawings and specifications. The Contractor is responsible for confirming and correcting all quantities; checking electrical characteristics and dimensions; selecting fabrication processes and techniques of construction; coordinating his work with that of all other trades; and performing his work in a safe and satisfactory manner.

B. Approval of shop drawings will not relieve this contractor from responsibility for deviations from the contract documents. It is the responsibility of the Contractor to meet the requirements of these documents. All errors or omissions in the product data are to be corrected by this contractor irrespective of any approvals by the Architect or Engineer.

C. Pre-test submittals must be written in report format, submitted and signed off on by the Owner and Engineer prior to the start of any construction work, including demolition.

D. Shop drawings include, but are not limited to, the submissions listed below. Refer to individual specification sections for specific requirements and additional submission requirements.

SECTION	DESCRIPTION	REQUIRED SUBMISSIONS
230010	Basic Mechanical Requirements	Access doors Fire Stopping Special requirements related to substitutions Sheet metal shop / coordination drawings Operation and Maintenance Manuals Record Documents / Drawings
230506	Painting of Mechanical Work	Product data for vehicles, primers and paints. (name, title, manufacturer, mfr's stock number, color name & number, & application instructions). Submit a schedule of surfaces/systems to be painted along with paint products and colors that shall be applied.
230509	Roof Curbs and Equipment Supports	Typical detail and schedule for equipment. Details shall include cross-sectional view illustrating clearly the type of curb being submitted, i.e. double wall insulated, with or without cant.
230513	Motors	Motor info with equipment submittal for equipment served.
230514	Electric Wiring	Complete wiring diagram for equipment and systems.
230519	Gauges and Thermometers	Manufacturer's data for each gauge and thermometer type. Submittal shall clearly designate where each device shall be utilized, including the scale range.
230523	Valves	Valves and accessories
230550	Wind Restraints for HVAC Systems.	Manufactures technical product data for wind restraint systems. Provide professional engineer stamped and signed calculations, and details of wind restraint systems to meet total design lateral force requirements for support and restraint of mechanical and electrical systems.
230553	Mechanical Identification	Manufactures technical product data and installation instructions for each identification material and device. Valve schedule for each piping system typewritten on an 8-1/2. X 11 in. (minimum) indicating code number, location and valve function. Schedule of pipe, equipment and name identification for review before stenciling or labeling. Confirm naming/numbering is consistent with Owner's convention.

230593	Testing, Adjusting and Balancing	Quality-Assurance Submittals Sample Report Forms Report of plan review for balancing devices necessary to achieve proper system balance but not specified Certified Testing, Adjusting, and Balancing Reports (including any specified pre-testing of systems) Warranty Documentation
230700	Insulation	Manufacturer data. Schedule of insulation applications. Certifications to demonstrate compliance specifications and governing regulations, including proof of compliance for test of products for fire rating, corrosiveness, and compressive strength.
230923	Temperature Controls	Control System Submittal Pre-Commissioning Report As-Built documentation and drawings Operations and Maintenance Manuals / Closeout Documentation Training Agenda and Documentation Warranty
232000	Piping Systems and Accessories	Schedule of pipe materials, fittings, connections and accessories by piping system.
232023	Pumps	Shop drawings and performance curves on pumps and pump accessories. Clearly indicate which equipment is being submitted.
232133	Water Systems Specialties	Shop drawings on water system specialties
233000	Sheet Metal and Ductwork Accessories	Shop drawings of all sheet metal equipment being provided. Submit a complete shop standard manual including construction details for all shop fabricated materials. Ductwork Detail Drawings. Exhaust and kitchen hood details.
233316	Fire and Smoke Dampers	Types, schedule of sizes, locations, and installation arrangements of all dampers. Manufacturers UL listed installation details for each mounting arrangement.
233400	Fans	Shop drawings on fans, motors, drives, and accessories. Include all fan curves and fan operating point.
233713	Registers and Diffusers	Registers/Grilles/Diffusers. Room schedule listing size, throw, direction of throw, accessories, finish, material type and color chart.
233726	Louvers and Penthouses	Louvers including all blade types, finishes and arrangements. Penthouses including materials, finishes and accessories. Provide original color charts for selection of finish

234000	Air Filters and Accessories	Filter product data including certification date, pressure drops at the scheduled airflow, schedule of filter sizes for each system. All filter accessories, including framing systems, fastening clips, manometers, and differential pressure gauges.
236213	Air Cooled Condensing Units	Air-cooled condensing unit, complete with accessories. Complete wiring and piping diagrams, showing all piping and control interconnection.
237219	Air to Air Energy Recovery Equipment	Shop drawings on components and accessories.
237313	Air Handling Units	Shop drawings on air handling units.
238146	Water Source Heat Pump and Accessories	Heat pump units and accessories. Power and control wiring diagrams, fan curves or charts, W.P.D, dimensions, weights, options for duct connections installation and start up manuals
238210	Hydronic Gravity Heating Equipment	Shop drawings on gravity heating equipment with color selection chart. Clearly indicate which equipment is being submitted.
238216	Coils	Shop drawing on coils.
238219	Fan Coil Unit	Room fan coil units and accessories including coil capacities, grille type and filters.
238223	Unit Ventilators	Unit ventilators and accessories including heating and cooling coil capacities, inlet and outlet types. Color chart.
238239	Unit Heaters and Cabinet Unit Heaters (Hydronic)	Unit heaters and cabinet unit heaters

3.2 COORDINATION DRAWINGS

A. Before construction work commences, Contractors for all trades shall submit Coordination Drawings in the form of color coded paper drawings or electronic files (dwg or rvt) not less than 3/8" = 1'-0" scale. Coordination Drawings are required throughout all areas for all trades. These drawings shall identify and show resolutions of trade conflicts. Mechanical Equipment Rooms shall be drawn early in the Coordination Drawing process, simultaneous with all other congested areas. Prepare Coordination Drawings as follows:

1. Division 23 shall prepare the base plan Coordination Drawings showing all ductwork and all pertinent piping and equipment. These drawings may be AutoCAD format of the required ductwork Shop Drawings. The drawings shall be coordinated with cable tray, light fixtures, sprinklers, air diffusers, other ceiling mounted items, ceiling heights, structural work, maintenance clearances, electric code clearance, reflected ceiling plans, and other contract requirements. Re-position proposed locations of work after coordination drawing review by the Construction Manager and the Architect. Provide adjustments to exact size, location and offsets of ducts, pipes, conduit, etc. Provide these adjustments as part of Base Bid Contracts.

2. Coordination drawings to include positioning of fire, smoke and combination damper assemblies, associated actuators and access / inspection doors and shall consider ceiling construction in final positioning based on ceiling type on either side of partition or barrier for optimum result.

3. Division 23 will provide AutoCAD files and prints and submit the base plan to all major trades' Contractors.

4. Division 26 (Electrical), Division 22 (Plumbing) and Division 21 (Fire Protection) will each draft location of piping, conduits, equipment, etc. on the base plan as provided by Division 23 such that a complete coordination of all trades is represented and areas of conflict and recommended resolutions are noted.

5. Do not install any equipment, equipment foundations, ductwork, or piping until Coordination Drawings have been approved. Failure to receive approval prior to installation of the aforementioned items, will put the risk on the contractor to remove and reinstall at the engineer’s discretion. Additional time spent by the engineer in the field reviewing construction progress due to not receiving ductwork shop drawings and coordination drawings prior, will be considered an additional service by the consultant, which shall be paid by the contractor and deducted from any moneys owed to the contractor. The consultant’s hourly rate will apply.

3.3 PROTECTION OF PERSONS AND PROPERTY

A. Contractor shall assume responsibility for Construction Safety at all times and provide, as part of contract, all trench or building shoring, scaffolding, shielding, dust/fume protection, mechanical/electrical protection, special grounding, safety railings, barriers, and other safety feature(s) required to provide safe conditions for all workmen and site visitors.

3.4 EXISTING SYSTEMS AND CONDITIONS

A. Existing conditions are taken from field observations and prior construction documents and are not guaranteed. The contractor shall field verify all existing conditions. No allowance will be made for additional costs due to Contractors failure to verify existing conditions.

B. Prior to beginning work, inspect the entire work area for defects in the existing construction such as scratches, holes etc. Submit a complete list and photographs of existing damage, to the Owner prior to beginning work. If existing damage is not documented and submitted, the Contractor shall repair all damage found at the completion of the project that is determined to have been caused by the work of this contract. Repairs shall restore the area to like new condition.

C. The Owner's Representative shall determine if the Contractor has damaged existing systems or construction and shall approve the repairs.

3.5 ASBESTOS RECOGNITION AND PRECAUTIONS

A. The Contractor shall be responsible for coordination of all required removal work, coring, cutting and patching with the Owner's asbestos management plan. Prior to performing such work, identify areas containing asbestos. Notify the Owner so that arrangements may be made for abatement and/or containment prior to work proceeding. The Contractor shall be responsible for cleaning all areas where asbestos is released due to the failure to coordinate with the asbestos management plan. Refer to Division 1 Sections for further requirements.

B. The disturbance or dislocation of asbestos-containing materials causes asbestos fibers to be released into the building's atmosphere, thereby creating a health hazard to workmen and building occupants. Consistent with Industrial Code Rule 56 and the content of recognized asbestos-control work, the Contractor shall apprise all of his workers, supervisory personnel, subcontractors, Owner and Consultants who will be at the job site of the seriousness of the hazard and of proper safeguards and work procedures which must be followed, as described in New York State Department of Labor Industrial Code Rule 56.

C. Refer to Division 2 sections for further requirements.

3.6 REMOVALS

A. Demolition of mechanical systems will include removal and deprogramming of multiple control system devices and sensors. Coordinate with Owner for quantity and type of devices which they desire to retain. Remove all components in good condition and turn over to the Owner's representative.

B. Where existing equipment removals are called for, submit complete list to Owner's Representative. All items that the Owner wishes to retain that do not contain asbestos or PCB Material shall be delivered to location directed by the Owner. Items that the Owner does not wish to retain shall be removed from site and legally disposed of. Removal and disposal of material containing asbestos and/or PCB's shall be in accordance with Federal, State and Local law requirements. Where equipment is called for to be relocated. Contractor shall carefully remove, clean and recondition, then reinstall. Remove all abandoned piping, wiring, equipment, lighting, ductwork, tubing, supports, fixtures, etc. Visit each room, each crawl space and each roof to determine total Scope of Work. Consistent with Industrial Code Rule 56 and the content of recognized asbestos-control work, the Contractor shall apprise all of his workers, supervisory personnel, subcontractors, Owner and Consultants who will be at the job site of proper safeguards and work procedures which must be followed, as described in New York State Department of Labor Industrial Code Rule 56.

C. Completely remove all piping, conduit, controls, and other devices associated with the equipment not to be reused in the new work. This includes all pipe, valves, fittings, insulation, conduit, panels, and all hangers, including the top connection and any fastenings to building structural systems. Where pipe and ductwork is removed and no new connections are planned or shown, cap, seal and insulate the pipe and ductwork which remains. Seal all openings, after removal of equipment, pipes, ducts, conduits and other penetrations in roof, walls, floors, in an approved manner and in accordance with plans and specifications where specifically covered. Structural integrity of the building system shall be maintained. Reference shall also be made to the architectural, structural, mechanical, site, and electrical drawings and specifications for additional facilities to be demolished or handled.

D. The shutting down of the existing HVAC systems shall be properly coordinated with the Owner. Provide the necessary personnel in shutting down the systems as necessary to facilitate the intended work. Water and glycol systems shall be fully drained prior to any removals. The Contractor shall propose to the Owner the points of isolation of the system to minimize the duration of the shutdown for draining, performing the necessary work and refilling of the system. Systems containing a glycol solution shall be drained in a manner to collect the solution in containers for storage or disposal. Glycol solution not utilized for refilling the systems upon completion of work shall be removed from the site and properly disposed of in a legal manner by the Contractor. Upon completion of removals and new work, the Contractor shall refill and vent the systems to return the systems back to their original operation condition.

3.7 STORAGE AND PROTECTION OF MATERIALS

A. Store Materials on dry base, at least 6" above-ground or floor. Store so as not to interfere with other work or obstruct access to buildings or facilities. Provide waterproof/windproof covering. Remove and provide special storage for items subject to moisture damage. Protect against theft or damage from any cause. Replace items stolen or damaged, at no cost to Owner.

B. Refer to "General Conditions of the Contract for Construction."

3.8 FREEZING AND WATER DAMAGE

A. Take all necessary precautions with equipment, systems and building to prevent damage due to freezing and/or water damage. Repair or replace, at no change in contract, any such damage to equipment, systems and building. Perform first seasons winterizing in presence of Owner's operating staff.

3.9 ROUGH-IN

A. Due to small scale of Drawings, it is not possible to indicate all offsets, fittings, changes in elevation, etc. Verify final locations for rough-ins with field measurements and with the equipment being connected. Verify exact location and elevations at work site prior to any rough in work. **DO NOT SCALE PLANS**. If field conditions, details, changes in equipment or shop drawing information require a significant change to the original documents, contact the Owner’s Representative for approval before proceeding.

B. All equipment locations shall be coordinated with other trades to eliminate interference with required clearances for equipment maintenance and inspections.

1. Coordinate work with other trades and determine exact routing of all duct, pipe, conduit, etc., before fabrication and installation. Coordinate with Architectural Drawings. Verify with Owner's Representative exact location and mounting height of all equipment in finished areas, such as thermostats, fixtures, communication and electrical devices, including panels. Coordinate all work with the architectural reflected ceiling plans and/or existing Architecture. Mechanical and electrical drawings show design arrangement only for Diffusers, grilles, registers, air terminals, lighting fixtures, sprinklers, speakers and other items. Do not rough-in contract work without reflected ceiling location plans.

2. Before roughing for equipment furnished by Owner or in other contracts, obtain from Architect and other contractors, approved roughing drawings giving exact location for each piece of equipment. Do not "rough in" services without final layout drawings approved for construction. Cooperate with other trades to insure proper location and size of connections to insure proper functioning of all systems and equipment. Obtain written authorization from the Owner’s Representative or other contractor for any “rough ins” that, due to project schedule, are required before approved coordination drawings are available. Any work installed without written authorization or approved coordination drawings, causing a conflict will be relocated by the Contractor at no expense to the Owner.

3. For equipment and connections provided in this contract, prepare roughing drawings as follows:

   a. Existing equipment being relocated: Measure the existing equipment and prepare drawings for installation in new location.

   b. New equipment: Obtain equipment roughing drawings and dimensions, then prepare rough-in drawings.

4. Where more than one trade is involved in an area, space or chase, all shall cooperate and install their own work to utilize the space equally between them in proportion to their individual requirements. In general, ductwork shall be given preference except where grading of piping becomes a problem, followed by piping then electrical wiring. If, after installation of any equipment, piping, ducts, conduit, and boxes, it is determined that ample maintenance and passage space has not been provided, rearrange work and/or furnish other equipment as required for ample maintenance space. Any changes in the size or location of the material or equipment supplied, which may be necessary in order to meet field conditions or in order to avoid conflicts between trades, shall be brought to the immediate attention of the Owner's Representative and approval received before such alterations are made.

C. Provide easy, safe, and code mandated clearances at controllers, motor starters, valve access, and manufacturer’s recommended service clearances to allow for required maintenance and operation. Contractor shall relocate existing work in the way of new construction. VISIT SITE BEFORE BIDDING TO DETERMINE SCOPE OF WORK. Provide new materials, including new piping and insulation for relocated work.

D. All equipment requiring service and / or access shall be provided adequate clearances for this purpose. Any clearances described in manufacturer’s information, code requirements, etc., shall be taken into account in determining final rough-in positions. Reasonable access for maintenance and service shall be maintained. The most stringent standard, as determined by the Engineer, shall apply.

3.10 CUTTING AND PATCHING

A. Each trade shall include their required cutting and patching work unless shown as part of the General Construction work on the architectural drawings. Refer to "General Conditions of the Contract for Construction," for additional requirements. Cut and drill from both sides of walls and/or floors to eliminate splaying. Patch all abandoned penetrations left by removals of equipment or fixtures. Patch adjacent existing work disturbed by installation of new work including insulation, walls and wall covering, ceiling and floor covering, other finished surfaces. Patch openings and damaged areas equal to existing surface finish. Cut openings in prefabricated construction units in accordance with manufacturer's instructions.

3.11 CONCEALMENT

A. **Conceal all contract work** above ceilings and in walls, below slabs, and elsewhere throughout building. If concealment is impossible or impractical, notify Owner's Representative before starting that part of the work and install only after his review. In areas with no ceilings, install only after Owner's Representative reviews and comments on arrangement and appearance.

3.12 CHASES

A. New Construction:

1. Certain chases, recesses, openings, shafts, and wall pockets will be provided as part of "General Building Construction Plans and Specifications." Mechanical and Electrical Trades work shall provide all other openings required for their contract work.

2. Check Architectural and Structural Design and Shop Drawings to verify correct size and location for all openings, recesses and chases in general building construction work.

3. Assume responsibility for correct and final location and size of such openings.

4. Rectify improperly sized, improperly located or omitted chases or openings due to faulty or late information or failure to check final location.

5. Provide 18 gauge galvanized sleeves and inserts. Extend all sleeves 2" above finished floor. Set sleeves and inserts in place ahead of new construction, securely fastened during concrete pouring. Correct, by drilling, omitted or improperly located sleeves. Assume responsibility for all work and equipment damaged during course of drilling. Firestop all unused sleeves.

6. Provide angle iron frame where openings are required for contract work, unless provided by General Construction Contractor.

B. In Existing Buildings:

1. Drill holes for floor and/or roof slab openings.

2. Multiple pipes smaller than 1" properly spaced and supported may pass through one 6" or smaller diameter opening.

3. Seal voids in fire rated assemblies with a fire-stopping seal system to maintain the fire resistance of the assembly. Provide 18 gauge galvanized sleeves at fire rated assemblies. Extend sleeves 2" above floors.

4. In wall openings, drill or cut holes to suit. Provide 18 gauge galvanized sleeves at shafts and fire rated assemblies. Provide fire-stopping seal between sleeves and wall in drywall construction. Provide fire-stopping similar to that for floor openings.

3.13 ACCESS DOORS AND PANELS

A. Provide access doors, sized to permit complete access for any concealed and/or inaccessible junction boxes, control and monitoring devices, duct mounted fire alarm detectors and other electrical equipment requiring access for maintenance or operation.

B. Provide access doors, sized to permit compete access for all items requiring adjustment, such as balance dampers above solid ceilings.

C. Set frames accurately in position and securely attach to supports with face panels plumb and level in relation to adjacent finish surfaces.

D. Adjust hardware and panels after installation for proper operation.

E. Access doors and panels shall operate freely and be fully usable for their intended function.

3.14 FIRE-STOPPING

A. Fire-stopping for openings through fire and smoke rated wall and floor assemblies:

1. Provide materials and products listed or classified by an approved independent testing laboratory for "Through-Penetration Fire-Stop Systems." The system shall meet the requirements of "Fire Tests of Through-Penetration Fire-Stops" designated ASTM E814.

2. Provide fire-stop system seals at all locations where piping, tubing, conduit, electrical busways/cables/wires, ductwork and similar utilities pass through or penetrate fire-rated wall or floor assembly. Provide fire-stop seal between sleeve and wall for drywall construction.

3. The minimum required fire resistance ratings of the wall or floor assembly shall be maintained by the fire-stop system. The installation shall provide an air and watertight seal.

4. The methods used shall incorporate qualities, which permit the easy removal or addition of electrical conduits or cables without drilling or use of special tools. The product shall adhere to itself to allow repairs to be made with the same material and permit the vibration, expansion and/or contraction of any items passing through the penetration without cracking, crumbling and resulting reduction in fire rating.

5. Apply fire stopping within the temperature and humidity limits permitted by the manufacturer.

6. Provide rigid steel sleeves where non-armored cables pass through fire rated walls and barriers.

3.15 FLASHING AND SEALING

A. Openings through roofs shall be flashed in a manner to not affect roof guarantee or bond. Engage qualified Roofing Contractor licensed by the Roofing Manufacturer, as part of the contract. Provide non-ferrous flashing pieces, skirts, hoods and collars as required to make ducts, pipes, conduits, and other penetrations watertight. Where curbs are called for with respect to rectangular openings in new roofs, flashing will be done by others unless specifically indicated otherwise. Caulk and waterproof with additional material so as to seal airtight and watertight.

B. Where openings for pipe/duct penetrate through roofs into equipment pipe chases, mechanical spaces or penthouses, the penetration of the roof deck/slab shall be sleeved, sealed and firestopped as required. Insulate at base of pipe chase, mechanical space or penthouse to match insulation value of the roofing system.

C. Apply all flashing and sealers within the temperature and humidity limits permitted by the manufacturer.

3.16 SUPPORTS

A. Provide required supports, beams, angles, hangers, rods, bases, braces, and other items to properly support contract work. Supports shall meet the approval of the Owner's Representative. Modify studs, add studs, add framing, or otherwise reinforce studs in metal stud walls and partitions as required to suit contract work. If necessary, in stud walls, provide special supports from floor to structure above. For Precast Panels/Planks and Metal Decks, support mechanical/electrical work as determined by manufacturer and Owner's Representative. Provide heavy gauge steel mounting plates for mounting contract work. Mounting plates shall span two or more studs. Size, gauge, and strength of mounting plates shall be sufficient for equipment size, weight, and desired rigidity.

3.17 GENERAL INSTALLATIONS REQUIREMENTS

A. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed

B. Coordinate ordering and installation of all equipment with long lead times or having a major impact on work by other trades so as not to delay the job or impact the construction schedule. Pay close attention to equipment that must be installed prior to building enclosure.

C. Where mounting heights are not detailed or dimensioned, install systems, materials and equipment to provide the maximum headroom possible.

D. Set all equipment to accurate line and grade, level all equipment and align all equipment components.

E. Provide all scaffolding, rigging, hoisting and services necessary for erection and delivery of equipment and apparatus furnished into the premises. These items shall be removed from premises when no longer required.

F. No equipment shall be hidden or covered up prior to inspection by the Owner's Representative. All work requiring inspection which is concealed prior to approval shall be re-opened for inspection at the Contractor's expense. All work that is determined to be unsatisfactory shall be corrected immediately.

G. All work shall be installed level and plumb, parallel and perpendicular to other building systems and components.

H. Install access panels or doors where units are concealed behind finished surfaces.

3.18 PAINTING

A. This Contract Includes the following:

1. Painting for all cut and patch work performed as part of Division 23 contract.

2. Painting required for touch-up of surfaces damaged due to the installation of Division 23 work.

3. Painting as required to repair finish of equipment furnished.

4. Refer to Section 099000-Painting, for general description of materials and methods.

5. Painting as called for on Division 23 Drawings and/or Specifications.

3.19 ADDITIONAL ENGINEERING SERVICES

A. In the event the Consultant is required to provide additional engineering services as a result of substitution of equivalent materials or equipment by the Contractor, or changes by the Contractor in dimension, weight, power requirements, etc., of the equipment and accessories furnished, or if the Consultant is required to examine and evaluate any changes proposed by the Contractor for the convenience of the Contractor, then the Consultant's hourly rate and expenses in connection with such additional services shall be paid by the Contractor and shall be deducted from any moneys owed to the Contractor.

B. In the event the Consultant is required to provide additional engineering services as a result of Contractor's errors, omissions or failure to conform to the requirements of the Contract Documents, or if the Consultant is required to examine and evaluate any changes proposed by the Contractor solely for the convenience of the Contractor, then the Consultant's hourly rate and expenses in connection with such additional services shall be paid by the Contractor and shall be deducted from any moneys owed to the Contractor.

C. In the event the Consultant is required to initiate design changes due to failure of the contractor to properly coordinate with the construction schedule, and / or other trades, then the Consultant's hourly rate and expenses in connection with such additional services shall be paid by the Contractor and shall be deducted from any moneys owned to the Contractor.

3.20 ALL TRADES TEMPORARY HEAT

A. Refer to the Standard General Conditions of the Contract for Construction and Supplemental General Conditions.

3.21 HVAC MAINTENANCE OF SYSTEMS DURING TEMPORARY USE PERIODS

A. Provide each air handling system with a set of pre-filters in addition to the permanent filters. Furnish four sets of pre-filters for each system for use when system is operated for temporary heating or cooling. During such use, change pre-filters as often as directed by Owner's Representative. Provide necessary temporary throwaway filters in all return openings to keep dust out of ductwork. Change as often as necessary. Remove all such temporary filters upon completion. Use supply units only. Do not operate return fans.

B. Blank-off outside air intake opening during construction. Install first set of permanent filters and pre-filters. Install filters over all return air openings with adequate efficiency and capacity to keep construction dust and debris out of the duct systems. Contamination of the duct systems shall necessitate cleaning to dust free condition.

C. Adjust dampers on supply system.

D. Set all heating coil control valves for manual operation.

E. Do not install any grilles or diffusers at room terminal ends of ducts until permission is given.

F. Assume responsibility for systems and equipment at all times, even though used for temporary heat or ventilation.

G. Repair or replace all dented, scratched or damaged parts of systems.

H. Remove concrete, rust, paint spots, other blemishes, then clean.

I. Just prior to final acceptance, remove used final filter. Deliver all unused sets of pre-filters to the Owner and obtain written receipt. Properly lubricate system bearings before and during temporary use. Maintain thermostats, freeze stats, fire stats, overload devices, and all other safety controls in operating condition

3.22 TEMPORARY FACILITIES

A. Refer to the Standard General Conditions of the Contract for Construction and Supplemental General Conditions.

1. Continuity of operation of existing facilities will require temporary installation or relocation of equipment and piping.

2. All piping and equipment shall be properly supported, sloped to drain, operate without excessive stress, and shall be insulated where injury can occur to personnel by contact with operating facilities.

3. Temporary facilities and piping shall be completely removed and any openings in structures sealed. Provide necessary blind flanges and caps to seal open piping remaining pressurized.

3.23 CLEANING

A. It is the Contractor's responsibility to keep clean all equipment and fixtures provided under this contract for the duration of the project. Each trade shall keep the premises free from an accumulation of waste material or rubbish caused by his operations. The facilities require an environment of extreme cleanliness, and it is the Contractor's responsibility to adhere to the strict regulations regarding procedures on the existing premises. After all tests are made and installations completed satisfactorily:

1. Thoroughly clean entire installation, both exposed surfaces and interiors.

2. Remove all debris caused by work.

3. Remove tools, surplus, materials, when work is finally accepted.

B. Cleanliness of construction shall extend to include the interior and exterior surfaces of all equipment and systems provided under this contract. This includes, but is not limited to:

1. Unitary equipment exposed to occupant use (cabinet heaters, baseboard systems, etc.) Shall be thoroughly cleaned for final use both inside and out prior to project completion.

2. Equipment located in mechanical spaces shall be cleaned on the exterior such that no significant accumulation of debris or dirt is evident.

3. Interiors of all air handling equipment (rooftop systems, air handlers, etc.) shall be thoroughly cleaned on the interior such that no evidence of dust, dirt or debris remains prior to project turnover.

4. Ductwork systems – Ductwork shall be delivered to the job site with ends capped or covered to eliminate contamination during transportation and site storage. All open ends shall remain covered during the entire course of the construction process. Ductwork with evidence of dust, dirt or debris shall be thoroughly cleaned by an approved method prior project turnover.

3.24 HVAC EQUIPMENT CONNECTIONS

A. Provide final steam, condensate, hot water, glycol, chilled and condenser water, drain, vent, oil line and gas connections to all equipment as required by the equipment. Provide final connections, including domestic water piping, wiring, controls, and devices from equipment to outlets left by other trades. Provide equipment waste, drip, overflow and rail connections extended to floor drains.

B. Provide for Owner furnished and Contractor furnished equipment all valves, piping, piping accessories, traps, pressure reducing valves, gauges, relief valves, vents, drains, insulation, sheet metal work, controls, dampers, as required.

C. Refer to manufacturer's drawings and specifications for requirements of medical equipment, laboratory equipment and special equipment. Verify connection requirements before bidding and confirm prior to roughing.

3.25 CONTINUITY OF SERVICES

A. The building will be in use during construction operations. Maintain existing systems in operation within all rooms of building at all times. Refer to "General Conditions of the Contract for Construction" for temporary facilities for additional contract requirements. Schedules for various phases of contract work shall be coordinated with all other trades and with Owner's Representative. Provide, as part of contract, temporary mechanical connections and relocation as required to accomplish the above. Obtain approval in writing as to date, time, and location for shut-down of existing mechanical facilities or services.

3.26 START UP AND OWNER INSTRUCTIONS

A. Before acceptance of the work, furnish necessary skilled labor to operate all systems by seasons. Instruct the Owner's designated personnel on the proper operation and maintenance of systems and equipment. Obtain written acknowledgment from person instructed. Prior to acceptance repeat the instructions. If asked to do so. Contractor is fully responsible for systems until acceptance, even though operated by Owner's personnel, unless otherwise agreed in writing. Provide operating, maintenance and starting precautions and procedures to be followed by the Owner for operating systems and equipment. Mount the instruction in clear plastic holder on or adjacent to the equipment.

B. Where supervision by a manufacturer is called for, provide manufacturer's certified technician or engineer to supervise the startup, testing and adjustment of the equipment or system. Where two or more manufacturers are involved (i.e. adjustable speed drive and air handling unit) both manufacturers shall be present at start up. The manufacturer shall provide a written report detailing the testing and start-up, including problems that occurred and their method of resolution.

C. Refer to Section 017500 - Starting and Adjusting and Section 017700 – Closeout Procedures for additional requirements.

3.27 OPERATION AND MAINTENANCE MANUALS

A. In addition to requirements stated elsewhere in these specifications, provide Operating and Maintenance manual(s) which include the following:

1. Approved Submittal documentation for all equipment stating size and selected options for each piece of equipment requiring maintenance.

2. Manufacturer's operation manuals and maintenance manuals for each piece of equipment requiring maintenance (excepting equipment not furnished as part of this project). Routine maintenance actions shall be clearly identified. The data shall include internal wiring diagrams and spare parts lists.

3. Name and address of each equipment supplier and at least one service agency for each piece of equipment.

4. HVAC and service water controls system maintenance and calibration information, including wiring diagrams, schematics, and control sequence descriptions. Desired or field-determined setpoints shall be permanently recorded on control drawings and at control devices or, for digital control systems, in programming instructions.

5. A narrative of how each system is intended to operate, including recommended setpoints. Include emergency operating instructions, seasonal changeover, freeze protection and precautions necessary for Owner operations of systems.

6. As-built drawings for the project (see Record Documents) and piping diagrams.

B. Bind above items in a three ring binder with name of project on the cover. Deliver to Owner's Representative before request for acceptance. Provide copy of O&M Manual in electronic format on CD or other media format acceptable to the Owner. All documents shall be in PDF format, with the exception of record drawings which shall be provided in AutoCAD compatible drawing format.

3.28 RECORD DOCUMENTS

A. In addition to all requirements elsewhere in the Contract Documents, prepare and provide record documents of the as-constructed work which meets the following minimum standards:

1. Utilities below floors, slabs and grade: During construction, maintain accurate records of all final locations and inverts for all services inside and outside of the buildings, beneath grade and below floors.

2. Ductwork and Piping:

a. All ductwork and piping shall be clearly dimensioned with its outside dimensions (diameter or length X width) at each unique section/piece.

b. Elevations of all ductwork and piping shall be clearly identified. Elevation should be taken in respect to the finish floor and bottom of ductwork or pipe.

c. X/Y dimensions should be included for all ductwork and piping to provide precise location from a fixed bench-mark such as the corner of a building, column, etc., and neatly and clearly indicate same on reproducible prints.

3. Provide Record Drawings for all Contract Work. Document the location of control devices isolation valves, safety devices and equipment.

4. Incorporate all field changes, change orders and other modifications into the final Record Drawings.

5. Record drawings shall contain all corrections from construction documents to as-built conditions and shall be submitted for review and approval.

6. Drawing format:

   a. Documents shall be provided in PDF formant or, where fully developed in CAD, in AutoCAD compatible file format. Submittal media shall be as acceptable to the Owner and Engineer

   b. Drawings scale shall not be less than 3/8" = 1'-0".

   c. Marked up PDFs of the contract documents will not be acceptable

3.29 SALVAGEABLE MATERIALS

A. Salvageable materials will be reviewed and identified by the Owner. Instruction shall be given to the Contractor whether the Owner will remove salvageable materials, or whether contractor is to remove and deliver salvageable materials to a pre-designated site.

B. HVAC items normally accepted as salvage by the Owner:

   1. Temperature control and automation hardware

END OF SECTION 230010

SECTION 230506 - PAINTING OF MECHANICAL WORK

1.0 PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Painting of mechanical related work specified in the Contract Documents including, but not limited to, the following:

1. Exposed piping systems
2. Exposed ductwork systems
3. Exposed mechanical insulation
4. Exposed mechanical equipment
5. Color-coded work
6. Steel supports, hangers and rods
7. Access Doors

1.2 RELATED DOCUMENTS

A. All work under this section is subject to the Contract Documents. This Contractor shall be responsible for and governed by all requirements therein.

1.3 SUBMITTALS

A. Submit product data for vehicles, primers and paints including name, title, manufacturer, manufacturer's stock number, color name and number, and application instructions. Submit a schedule of surfaces/systems to be painted along with paint products and colors that shall be applied.

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver painting materials to job site in original, new and unopened packages and containers bearing manufacturer's name and label showing the following information:

1. Name and title of material
2. Manufacturer's stock number and date of manufacture
3. Contents by volume, for major pigments and vehicles
4. Thinning instructions
5. Application instructions
6. Color name and number

B. Store materials in approved fire-safe location with adequate ventilation. Area must be kept clean.

2.0 PART 2 - PRODUCTS

2.1 GENERAL PAINTING PRODUCT REQUIREMENTS

A. Painting products based on a system by Rust-Oleum. Other equivalent systems may be approved.

B. Steel surfaces – normal temperatures:

1. First Coat – Rust-Oleum #769 Red Primer.

2. Second Coat – Rust-Oleum #7400 Zinc Chromate Primer.

3. Third Coat – Rust-Oleum finish, colors as directed.

C. Steel surfaces – elevated temperatures above 150 degrees F.

1. First Coat – Rust-Oleum #819 heat resistant primer.

2. Second Coat – Rust-Oleum #55 heat resistant aluminum finish paint, color to match existing or as directed by Engineer.

3. Machinery, equipment and apparatus having factory applied prime coat shall be painted as specified above except omit first coat.

D. Vehicles and thinners: Comply with governing regulations and recognized safe practices in handling, use and drying of paint vehicles and thinners. Compatibility of paint products is the Contactor's exclusive responsibility. Select paint products to ensure freedom from problems relating to vehicles and thinners of type and within limits recommended by paint manufacturer.

3.0 PART 3 - EXECUTION

3.1 GENERAL

A. Clean surfaces before applying paint products. Remove oil and grease prior to mechanical cleaning. Comply with paint products manufacturer's instructions for surface cleaning and preparation. Remove surface applied accessories which are not to be painted, and reinstall after completion of painting. Protect non-removable items not to be painted, by covering with paper or plastic film.

B. Ferrous metal surfaces: Remove mill scale and loose rust on surfaces which are not zinc coated or shop/factory prime coated.

1. Clean shop applied prime coats on metal surfaces, and repair (touch-up) prime coats wherever abraded or otherwise damaged, prior to application of paint system.

2. Zinc coated surfaces: Clean with non-petroleum based solvent. Wash with copper sulfate solution and flush with water, unless surface has been pre-treated, or unless treatment is not recommended by manufacturer of prime coat.

3.2 PAINT SYSTEM APPLICATION

A. Comply with manufacturer's recommendations for mixing or stirring paint products immediately before application.

B. Application limitations: Paint every accessible surface of each unit of work indicated to be painted, regardless of whether in location recognized as "concealed" or "exposed" except as otherwise indicated.

1. Omit painting on machined sliding surfaces and rotating shafts of equipment, and on nonferrous finished metals including chrome plate, stainless steel, special anodized aluminum, brass/bronze and copper, and on plastics and similar finished materials, except where specifically indicated to be color-coded by painting.

2. Omit painting on required name plates, labels, identification tags, signs, markers, printed instructions, performance ratings, flow diagrams and similar test and graphics, located within the scope of work indicated to receive paint application.

3. Omit specified prime coat of paint system for metal surfaces where surface has shop applied prime coat of equivalent quality. Apply prime coat on other surfaces to be painted, comply with paint manufacturer's instructions for prime coating where not otherwise indicated. Apply additional prime coats where suction spots or unsealed areas appear.

C. Apply paint in accordance with manufacturer's directions. Apply additional coats when undercoats, stains or other conditions show through final coat of paint, until paint film is of uniform finish, color and appearance. Apply paint at edges, corners, joints, welds and exposed fasteners in manner which will ensure dry-film thickness equal to that of flat surfaces. Allow sufficient time between successive coats for proper drying (comply with manufacturer's drying instructions).

1. Number of coats: Number indicated is minimum number, apply as many coats as are necessary to cover.

2. Coating thickness: Apply paint in uniform coats without thinning and in application thickness recommended by manufacturer for each coat.

3. Apply paint in smooth finish without noticeable texture, cloudiness, spotting, holidays, laps, brush marks, runs, sags, ripples, ropiness and other surface imperfections.

3.3 CLEAN UP AND PROTECTION, PAINTING

A. During progress of work, remove from site discarded paint materials, rubbish, cans and rags at end of each work day. Do not leave in paint storage area.

B. Spattered surfaces: Upon completion of painting work, clean paint spattered surfaces. Remove spattered paint by proper methods of washing and scraping, using care not to scratch or otherwise damage finished surfaces.

C. Protection: Protect work of other trades, whether to be painted or not, against damage by painting work. Correct damage by cleaning, repairing or replacing and repainting as directed. Provide "Wet Paint" signs as required to protect newly painted finishes. Remove temporary protective wrappings installed for protection of work not to be painted, after completion of painting operations. At completion of work by other trades, touch up and restore damaged or defaced painted surfaces.

END OF SECTION 230506

SECTION 230509 - ROOF CURBS AND EQUIPMENT SUPPORTS

1.0 PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide labor, materials, equipment and services as required for the complete installation of roof curbs, as shown in the Contract Documents. This section applies to equipment used to support mechanical system components and is inclusive of curbs, equipment supports, support stands and penetration housings.

1.2 RELATED DOCUMENTS

A. All work under this section is subject to the Contract Documents. This Contractor shall be responsible for and governed by all requirements therein.

B. This contractor shall coordinate all final rail selections, including anchoring details to both equipment and building roof deck, with the requirements of specification Section 230550 (Wind Restraint for HVAC Systems). Final determinations as provided by the Engineer of Record for the seismic and/or wind restraint calculations shall override any similar information provided within these specifications and the project drawings.

1.3 SUBMITTALS

A. Typical detail and schedule for equipment used to support mechanical system components shall include cross-sectional view illustrating clearly the type of curb being submitted, i.e. double wall insulated, with or without cant.

2.0 PART 2 – PRODUCTS

2.1 ROOF CURBS

A. Curb constructed of galvanized steel, with continuous welded corner seams and painted at all welds. 20 gauge up to 36”., 18 gauge 38 to 72”., 16 gauge over 72” in any dimension. Minimum 22ga interior liner liner and 1-1/2” minimum thickness 3# density fiberglass insulation. All fans to have minimum 18" high curbs, with the exception of kitchen fans which shall be equipped with 24" high vented style with hinges. Curb heights to be adjusted based on field verification of roofing system such that exhaust / relief outlets are no less than 18” above the membrane surface, and intakes no less than 24”. Provide curb with gasket on top to make airtight seal between curb and ventilator, fan, or air handling unit. Curb provided with raised cant, flanged or recessed to coordinate with roofing type. Curb flange shall suit roof construction, wind restraint requirements and type of insulation being applied.

B. Design Equipment: RPS Model RC Series.

C. Acceptable Make: Pate, Shipman & Son, RPS.

2.2 EQUIPMENT SUPPORTS

A. Double wall, 2 in. x 8 in. wood blocking, minimum 18" high. Fully insulated in the interior cavity with rigid insulation on supports which are 10" or wider. Constructed of 18 gauge galvanized steel with continuous welded corner seams and painted at all welds. 1 ½" minimum thickness 3# density fiberglass insulation. Constructed of heavier gauge steel where standard curb cannot support unit weight. Provide with top cap counter flashing. Support provided with raised cant, flanged or recessed to coordinate with roofing type. Support flange shall suit roof construction, wind restraint requirements and type of insulation being applied.

B. Design Equipment: RPS Model ER-2A.

C. Acceptable Makes: Pate, Shipman & Son, RPS.

2.3 PIPE SUPPORTS ASSEMBLY

A. Same construction as "Equipment Supports." Provide with full length steel bracket, U-bolts and accessories as required to secure piping to the pipe support as detailed on Contract Drawings.

B. Design Equipment: RPS Model ER-2A.

C. Acceptable Makes: Pate, Shipman & Son, RPS.

2.4 PIPE CURB ASSEMBLY

A. 2" x 2" continuous cap blocking, fully insulated with rigid 1-1/2" 3# density insulation. Minimum 18" high. Constructed of 18 gauge galvanized steel with welded at all contact points. Painted at all welds. Acrylic coated, ABS rib reinforced curb cover and integral counter flashing, size and number of pipe and conduit openings as required to suit job conditions. EPDM protective rubber pipe boots and stainless steel clamps secured around each pipe individually. Curb provided with raised cant, flanged or recessed. Curb flange shall suit roof construction and type of insulation being applied.

B. Design Equipment: RPS N Series with RC Series curb system.

C. Acceptable Makes: Pate, Shipman & Son, RPS.

3.0 PART 3 - EXECUTION

3.1 GENERAL

A. Height as recommended by equipment manufacturer, not less than described in Part 2.0. This Contractor shall be responsible for exact size, length, and location and shall set and secure each curb to roof. Shim and level curb as required. Provide curb and supports for all roof-mounted equipment. All roof penetrations shall be made through an appropriate curb. All roof-mounted equipment including fans, air handling units, etc., shall be set on an equipment support unless otherwise noted. Refer to Contract Drawings for details on plenums extending from curbs.

END OF SECTION 230509

SECTION 230513 – MOTORS

1.0 PART 1 – GENERAL

1.1 DESCRIPTION

A. Provide labor, materials, equipment and services as required for the complete installation designed in Contract Documents.

1.2 SUBMITTALS

A. Submit motor information with submittal for equipment served, when applicable. Motor submittal shall include manufacturer's name and model number, motor type, motor characteristics including voltage, phase, horsepower, and speed.

1.3 RELATED SECTIONS

A. Section 262923 – Adjustable Speed Drives

2.0 PART 2 – PRODUCTS

2.1 MOTORS

A. General Requirements:

1. Motors built for 60 Hz operation, three phase for 1/2 hp and larger; single phase for 1/3 hp and smaller. In compliance with NEMA Standards, wound specifically for nameplate voltage, and selected for appropriate duty and environment. Minimum service factor of 1.15 at rated voltage and frequency. Bearings ABMA L10 rated for 5 years continuous, non-severe duty. V-belt connected motors with adjustable slide rail bases and pulleys. Motors shall have Class F insulation system, with Class B temperature rise. Maximum allowable motor temperature rise for open drip-proof or totally enclosed fan cooled (TEFC) type at 1.15 service factor shall be 80^{o}C above 40^{o}C ambient up to 300 hp. NEMA locked rotor KVA code as required to match unit equipment torque characteristics. Single-phase motors shall be capacitor start, induction run, or split phase type. Polyphase motors shall be constant speed, squirrel cage, unless otherwise called for. Motors for solid state driven, variable speed fans or AHU units shall be designed for definite purpose energy efficient drive control.

2. Fractional HP Fan Motors between 1/12 and 1 hp shall be electronically commutated motors or have a minimum motor efficiency of 70%, rated in accordance with DOE 10 CFR 431. Motors shall be provided with motor speed adjustment for balancing and / or remote control as may be required by the sequences of operation. The use of belt driven fans to sheave adjustments for air flow balancing in lieu of varying motor speed is permitted.

   a. Exceptions:

      1) Motors in the air stream of fan coils and terminal units that only provide heating to the space served.

      2) Motors in systems which meet the efficiency ratings in part 403 of the IECC while accounting for motor power in the efficiency calculations.

3. Three Phase Motors rated 1 hp and greater shall meet the following nominal efficiency ratings:

   a. Minimum Nominal Full-Load Efficiency for 60 Hz NEMA General Purpose Electric Motors (Subtype I) rated 600 Volts or less (Random Wound)

Motor Horsepower	Number of Poles	Open Drip Proof Motors			Totally Enclosed Fan Cooled Motors		
		2	4	6	2	4	6
	Synchronous Speed (RPM)	3600	1800	1200	3600	1800	1200
1		77.0	85.5	82.5	77.0	85.5	82.5
1.5		84.0	86.5	86.5	84.0	86.5	87.5
2		85.5	86.5	87.5	85.5	86.5	88.5
3		85.5	89.5	88.5	86.5	89.5	89.5
5		86.5	89.5	89.5	88.5	89.5	89.5
7.5		88.5	91.0	90.2	89.5	91.7	91.0
10		89.5	91.7	91.7	90.2	91.7	91.0
15		90.2	93.0	91.7	91.0	92.4	91.7
20		91.0	93.0	92.4	91.0	93.0	91.7
25		91.7	93.6	93.0	91.7	93.6	93.0
30		91.7	94.1	93.6	91.7	93.6	93.0
40		92.4	94.1	94.1	92.4	94.1	94.1
50		93.0	94.5	94.1	93.0	94.5	94.1

Note: Nominal efficiencies shall be established in accordance with DOE 10 CFR 431.

b. Minimum Average Full Load Efficiency Polyphase Small Electric Motors:

Motor Horsepower	Open Motors			
	Number of Poles	2	4	6
	Synchronous Speed (RPM)	3600	1800	1200
0.25		65.6	69.5	67.5
0.33		69.5	73.4	71.4
0.50		73.4	78.2	75.3
0.75		76.8	81.1	81.7
1		77.0	83.5	83.8
1.5		84.0	86.5	83.8
2		85.5	86.5	N/A
3		85.5	86.9	N/A

c. Minimum Average Full Load Efficiency for Capacitor-Start Capacitor-Run and Capacitor-Start Induction-run Small Electrical Motors

Motor Horsepower	Open Motors			
	Number of Poles	2	4	6
	Synchronous Speed (RPM)	3600	1800	1200
0.25		66.6	68.5	62.2
0.33		70.5	72.4	66.6
0.50		72.4	76.2	76.2
0.75		76.2	81.8	80.2
1		80.4	82.6	81.1
1.5		81.5	83.8	N/A
2		82.9	84.5	N/A
3		84.1	N/A	N/A

d. Minimum Nominal Full-Load Efficiency of General Purpose Electric Motors (Subtype II) and all Design B Motors Greater than 200 Horsepower

Motor Horsepower	Number of Poles	Open Drip Proof Motors				Totally Enclosed Fan Cooled Motors			
		2	4	6	8	2	4	6	8
	Synchronous Speed (RPM)	3600	1800	1200	900	3600	1800	1200	900
1		NR	82.5	80.0	74.0	75.5	82.5	80.0	74.0
1.5		82.5	84.0	84.0	75.5	82.5	84.0	85.5	77.0
2		84.0	94.0	85.5	85.5	84.0	84.0	86.5	82.5
3		84.0	86.5	86.5	86.5	85.5	87.5	87.5	84.0
5		85.5	87.5	87.5	87.5	87.5	87.5	87.5	84.0
7.5		87.5	88.5	88.5	88.5	88.5	89.5	89.5	85.5
10		88.5	89.5	90.2	89.5	89.5	89.5	89.5	88.5
15		89.5	91.0	90.2	89.5	90.2	91.0	90.2	88.5
20		90.2	91.0	91.0	90.2	90.2	91.0	90.2	89.5

25		91.0	91.7	91.7	90.2	91.0	92.4	91.7	89.5
30		91.0	92.4	9.4	91.0	91.0	92.4	91.7	91.0
40		91.7	93.0	93.0	91.0	91.7	93.0	93.0	91.0
50		92.4	93.0	93.0	91.7	92.4	93.0	93.0	91.7
60		93.0	93.6	93.6	92.4	93.0	93.6	93.6	91.7
350		95.0	95.4	95.4	NR	95.4	95.4	95.0	NR
400		95.4	95.4	NR	NR	95.4	95.4	NR	NR
450		95.8	95.8	NR	NR	95.4	95.4	NR	NR
500		95.8	95.8	NR	NR	95.4	95.8	NR	NR

Note: Nominal efficiencies shall be established in accordance with DOE 10 CFR 431.

4. Nominal Motor Voltage Table:

Nominal System Voltage	Motor Nameplate
480V - 3 phase	460 volt
240V - 1 phase and 3 phase	230 volt
208V - 1 phase and 3 phase	200 volt
120V - 1 phase	115 volt

5. Motor Application:

Environment/Location	Motor Enclosure Type
General Purpose	Open drip-proof, TEFC, or encapsulated
Outdoors, below grade or high humidity	TEFC
Packaged Refrigeration Compressors	Hermetic or semi-hermetic

6. Make: Need not be all of same make, but one of the following: General Electric, Gould, Reliance, Westinghouse, Marathon, Baldor or equal.

2.2 SHAFT GROUNDING RINGS

A. Motors for Use with Adjustable Speed Drives:

1. All motors with Adjustable Speed Drives, whether factory provided or field applied, shall be equipped with shaft grounding rings.

2. Shaft Grounding Ring on NEMA Premium® and inverter duty motors consisting of conductive microfibers and grounding path.

B. Shaft Grounding Kit for Field Installation

1. Field applied shaft grounding ring for motors controlled by adjustable speed drives designed to be installed by contractor.

3.0 PART 3 – EXECUTION

3.1 MOTORS

A. Furnished by equipment manufacturer and especially manufactured and/or selected, mounted, and installed for intended use. Install motors accessible for maintenance and belt adjustment.

3.2 REPLACEMENT OF EXISTING MOTORS

A. Field verify existing motor characteristics and provide motors as called for. Modify or replace existing motor mounts and bases to accommodate the replacement motors. Replace drive and driven sheaves and provide a heavy duty belt set.

3.3 SHAFT GROUNDING RINGS

A. Motors: Wire Shaft Ground Kit on motors for use with Adjustable Speed Drives

1. Ensure shaft grounding kit is installed on motor accordance with manufacturer's recommendation.

2. Shaft grounding ring (SGR) is bolted directly to the motor end bracket or installed with conductive epoxy to ensure ground connection from the SGR to motor frame.

END OF SECTION 230513

SECTION 230514 - ELECTRIC WIRING

1.0 PART 1 – GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services for the complete installation of motor control, equipment manufacturer remote device and temperature control wiring as required for a fully functional system. Provide interlock wiring from safety devices (freezestats, flow switches, etc.) to control panels. Provide wiring and conduit required to connect devices furnished as part of or adjunctive to the automatic temperature control system and for motor control regardless of the source of supply. Control wiring includes 120 volt and lower voltage wiring for control signals directing equipment operation. Control circuits shall be 120 volt maximum. Provide devices required for proper system operation, including special electrical switches, transformers, disconnect switches, relays, and circuit breaker protection.

B. Coordinate all work with Division 26, "Electrical".

1.2 RELATED SECTIONS

A. All work under this section is subject to the Contract Documents. This Contractor shall be responsible for and governed by all requirements therein.

B. This Section applies to all work provided under division 23.

1.3 WORK NOT INCLUDED

A. Power wiring for motors, motor starters and associated starting and control equipment, as well as the motor starters (except in the case of equipment specified to have packaged controls/starters), are included in Division 26, "Electrical," unless otherwise called for.

1.4 QUALIFICATIONS

A. Wiring installed in compliance with all requirements of Division 26, "Electrical" and the National Electric Code.

1.5 SUBMITTALS

A. Provide submittals including complete wiring diagrams for equipment and systems. Deliver wiring diagrams to proper trades in time for roughing of conduit, equipment connections, and to avoid delay in construction schedule. Wiring diagrams and roughing information shall clearly indicate scope of work that is part of the Work of Division 26, "Electrical".

2.0 PART 2 – PRODUCTS

2.1 PRODUCTS

A. Refer to Division 26 specifications for required wiring materials.

B. All wiring system materials within plenums shall be non-combustible or shall be listed and labeled as having a flame spread index not more than 25 and a smoke developed index of not more than 50 when tested in accordance with ASTM E84 or UL 723. These requirements include control system components and all associated components. All electrical and control components not conforming to these requirements must be fully contained in a non-combustible enclosure or raceway unless listed and labeled for such use under UL 2043.

C. Combustible electrical wires and cables and fiber-optic cables exposed within a plenum shall be listed as having a peak maximum optical density of 0.50 or less and an average optical density of 0.15 or less, and a maximum flame spread distance of 5 ft. or less when tested in accordance with NFPA 262 or shall be installed in metal raceways or sheathed cable. Combustible optical fiber and communication raceways exposed within a plenum shall be listed to the same maximum and average optical densities and flame spread distance under ANSI/UL 2024. Only plenum rated wires and cables shall be installed in plenum rated raceways.

3.0 PART 3 – EXECUTION

3.1 GENERAL

A. Check electrical wiring pertaining to equipment for completeness and correctness of connections. Correct any misapplied motor and/or motor starter, improper thermal overload device, or device which fails to function and resultant damage, whether due to incorrect connections or improper information on wiring diagrams.

B. All wiring which passes through an enclosure, wall stud, framing, or other material where abrasion to the wiring system is a long term risk shall be protected using bushing inserts. Electrical tape or other removal media is not considered proper protection against abrasion.

C. Final connections to equipment shall be provided with using flexible whips no longer than 18 inches in length terminated using appropriate connectors.

D. Conduits mounted directly to the outside of insulated plenums, equipment or ductwork shall be installed using appropriate standoff's to avoid compressing the insulation and reducing the value. Repair all insulation damaged during conduit and wiring system installation.

E. Wiring shall be appropriately trimmed and terminated at all equipment. Bundled excess wiring "loops" will not be permitted.

3.2 WIRING FOR CONTROL SYSTEMS

A. Provide motor control, temperature control, interlock, safety device and instrumentation wiring for equipment. All wiring shall be in conduit. Refer to Division 26 for type of conduit to be used in specific applications. Provide 18 in. long flexible conduit at motors and devices subject to vibration. Conduit shall be supported on 5 ft. centers. Do not attach directly to hot surfaces, piping, or ductwork. Control wiring shall be in separate conduit from all other wiring. Provide green grounding wire circuited from starter, and run ground wire through conduit to each remote auxiliary relay, pushbutton station, remote panel heating device, thermostat, or device with potentials in excess of 50 volts. Size ground wire as required by NEC.

B. Provide pushbutton stations, pilot lights, selector switches, auxiliary starter contacts, and other devices required to provide specified functions.

C. Where allowable by Code and contract documents, temperature control wiring may be installed without conduit. Installation and wire insulation types shall be as described by NEC, Article 725. All low voltage wiring circuits 50V and under shall:

1. When installed horizontally above accessible ceilings low voltage wiring may be run without conduit. Cables shall be supported using bridle rings attached to building structure. Wherever possible, wiring shall be bundled to avoid clutter in the ceiling cavity, and wiring runs shall be provided parallel and perpendicular to building lines.

2. All exposed wiring in occupied spaces shall be run in surface metal raceway, wiremold v700 series where no access is available to wall cavity.

3. In locations where control wiring is being run to wall mounted sensors, the conduit within the stud wall, as well as the junction box, shall be of non-metallic construction. Carlon Flex-Plus Blue Electrical Non-metallic Tubing and Accessories, or equal.

4. All cases not specifically covered by the above cases shall be run in conduit.

3.3 EQUIPMENT WIRING

A. Provide power and control wiring between sections of electric radiation units, between shipping splits, and between remote panels, thermostats, disconnect switches, and their respective units. Provide control wiring from the package control system, to each respective electric heat coil, reheat coil or motor. Properly mount control package. Power wiring to and including disconnect switch shall be by Division 26 "Electrical".

3.4 FIELD WIRING IN STARTERS, CONTROLLERS, AND PANELS

A. Wiring within starters, controllers, and temperature control panels, shall be routed neatly in gutter space, away from moving and/or heat producing parts. Provide 30 ampere, 600 volt rated terminal blocks. Do not place more than two wire connections on pilot device or relay terminal. Where more than two circuit connections are required, use terminal blocks. Provide nylon self-insulated, locking type spade lugs for all control wires. Cables and wires shall be neatly bundled and lashed with nylon cable straps. All wiring installed in a single enclosure shall be rated for the maximum voltage in said enclosure or physical separation provided in compliance with the NEC.

END OF SECTION 230514

SECTION 230519 - GAUGES AND THERMOMETERS

1.0 PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services to perform operations required for the complete installation and related Work as required in Contract Documents.

1.2 RELATED DOCUMENTS

A. All work under this section is subject to the Contract Documents. This Contractor shall be responsible for and governed by all the requirements therein.

1.3 SUBMITTALS

A. Submit manufacturer's data for each gauge and thermometer type. Submittal shall clearly designate where each device shall be utilized, including the scale range.

2.0 PART 2 - PRODUCTS

2.1 WATER PRESSURE GAUGES

A. Construction shall be Bourdon tube type; 4-1/2 in. diameter minimum dial face, in stainless steel case and plastic lens. Phosphor bronze tube, phosphor bronze bushed rotary movement, silver brazed or soldered to brass socket and brass tip, 1/4 in. bottom connection. Accuracy, one (1.0) percent of included scale range. White dial face with black numerals, graduated in pounds per square inch (psi); equipped with bronze adjustable pressure snubber and ball valve. Ball valve shall meet the requirements of Specification Section 230523 for the system it is serving.

B. Make: American, Ashcroft, Crosby, Duro, Marsh, Moeller, Trerice, Weiss, Weksler.

2.2 PIPING SYSTEM THERMOMETERS

A. Vertical liquid filled type - Industrial type, black molded ABS or aluminum case with glass or plastic front, mercury free blue reading column, V-shaped aluminum scale, black numerals. Union flange mounted, separable socket, extension necks where required; range as called for based on service. Universal adjustable type, 9 in. scale size. For installation in water systems where the maximum temperature is less than 120°F: graduations of 1°F, accurate to within 1°F. For installation in hot water systems: graduations of 2°F, accurate to within 2°F.

1. Make: American, Moeller, Trerice, Weiss, Weksler.

2.3 PRESSURE/TEMPERATURE TEST PLUGS

A. 1/4 in. NPT plug shall be capable of receiving either a pressure or temperature 1/8 in. o.d. probe. Dual seal core of Nordel 275°F with zero leakage from vacuum to 500 psig.

B. Makes: Peterson Equipment Company, Sisco P/T plugs.

3.0 PART 3 - EXECUTION

3.1 WATER PRESSURE GAUGES

A. Provide ball valve on each gauge line meet the requirements of Specification Section 230523.

B. Provide water pressure gauge in piping systems where called for and where scheduled below:

1. Provide ball valve in each pump inlet and outlet tapping, or in piping adjacent to same. Range: 30 in. vacuum to 100 psi.

2. Compression tanks: 0 to 100 psi range.

3. Each water make-up valve assembly: 0 to 60 psi range.

3.2 PIPING THERMOMETERS

A. Mounted in oversize tee or elbow if necessary, to provide as little restriction as possible to fluid flow and maintain sensing bulb fully in measured media, with stems of proper length to allow accurate reading. Locate adjacent to control sensing equipment. Arrange so as to be easily read from floor.

B. Select thermometers from manufacturer's standard equipment such that anticipated measurements will reside generally in the middle third of the instrument's range.

3.3 TEST PLUGS

A. Provide test plugs at gauge and thermometer locations as called for.

END OF SECTION 230519

SECTION 230523 – VALVES

1.0 PART 1 – GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment, and services as required for the complete installation and related work designated in contract documents.

1.2 RELATED DOCUMENTS

A. All work under this section is subject to the Contract Documents and this Contractor shall be responsible for and governed by all the requirements therein.

1.3 SUBMITTALS

A. Valves and accessories.

2.0 PART 2 – PRODUCTS

2.1 VALVES:

A. General: Valves shall meet the following requirements:

1. Working pressure shall be stamped or cast on bodies.

2. Stem packing shall be serviceable without removing valve from line.

3. To establish a standard of quality and identify features, certain manufacturer's numbers are given in the following paragraphs.

B. Swing Check Valves – HVAC Systems (Non-Potable Water Systems):

1. **CV-01 -** Bronze 2" and Under (Threaded and Soldered End Connections):

a. Valves shall be suitable for 125 SWP/200WOG, 150 SWP/300 WOG or 300 SWP/ 1000WOG, renewable disc, T-Pattern or Y-Pattern.

b. Body and Cap: Bronze ASTM B62.

c. Lever: Stainless steel or brass.

d. Disc: Bronze ASTM B16, ASTM B453, or ASTM B61.

e. Acceptable Makes: Milwaukee 509/1509 (Class 125), 515/1515 (Class 150) or 507 (Class 300), Hammond IB904//IB912 (Class 125), IB515Y (Class 150) or IB949 (Class 300), Crane 37/ (Class 125), 137 (Class 150) or 36E (Class 300), Nibco T-413/S-413 (Class 125), T-433/S-433 (Class 150) or T-473 (Class 300), Apollo 161T (Class 125), 164T (Class 150).

2. **CV-03 -** Cast Iron 2 ½" and Larger (Flanged End Connection):

   a. Valves shall be Class 125 or Class 250, bolted cap.

   b. Body and Bonnet: Cast iron ASTM A126, Class B.

   c. Seat Ring: Bronze ASTM B62

   d. Disc: Cast iron ASTM A126, Class B or cast bronze ASTM B62

   e. Hinge: Ductile iron ASTM A536 or cast bronze ASTM B62.

   f. Acceptable Makes: Milwaukee F-2974A (Class 125) or F-2970-M (Class 250), Crane 373 (Class 125) or 39E (Class 250), Powell Figure 559 (Class 125), Lunkenheimer Figure 1790 IBBM (Class 125), Nibco F-918-B (Class 125) or F-968-B (Class 250).

C. Ball Valves: Domestic - Potable Water:

1. **BV-01 -** Bronze 2" and Under (Threaded and Soldered End Connections):

   a. Valve shall be suitable for 600 psi WOG non-shock, 150 psi WSP full port with blowout proof stem.

   b. Lead Free.

   c. Body: Bronze.

   d. Stem: Type 316 Stainless Steel ASTM A276.

   e. Ball: Type 316 Stainless Steel ASTM A276.

   f. Seats and Seals Stem Packing and Thrust Washer: PTFE.

   g. Handle: Zinc-plated carbon steel with vinyl insulator. Provide handle with extended stem on insulated piping. Provide locking lever.

   h. Adjustable stem packing.

   i. Acceptable Makes: Watts LFB6080-G2-SS (threaded) and LFB6081-G2-SS (solder), Apollo 77CLF-140-C (threaded) and 77CLF-240-C (solder), Milwaukee UPBA400S (threaded) and UPBA450S (solder), Nibco T-585-66-LF (threaded) and S-585-66-LF (solder), Hammond UP8303A (threaded) and UP8313A (solder).

D. Ball Valves – HVAC Systems (Non-Potable Water Systems):

1. General – Where ball valves are specified, provide 6" ball valves in 5" pipe. Provide required reducers.

2. **BV-03 -** Bronze 2" and under (Threaded and Soldered End Connections)

   a. Valve shall be suitable for 600 psi WOG non-shock, 150 psi WSP full port with blowout proof stem.

   b. Body: Bronze.

   c. Stem: 316 Stainless Steel.

   d. Ball: 316 Stainless Steel.

   e. Seats and Seals Stem Packing and Thrust Washer: PTFE.

   f. Handle: Zinc-plated carbon steel with vinyl insulator. Provide handle with extended stem on insulated piping. Provide locking lever.

   g. Adjustable stem packing.

   h. Acceptable Makes: Watts LFB6080-G2-SS (threaded) and LFB6081-G2-SS (solder), Apollo 77C-140 (threaded) and 77C-240 (solder), Milwaukee BA400S (threaded) and BA450S (solder), Nibco T-585-66 (threaded) and S-585-66 (solder), Hammond 8303A (threaded) and 8313A (solder).

3. **BV-08 -** Carbon Steel 2 1/2" to 12" (Flanged End Connection):

   a. Valve shall be Class 150 designed for 285 psi WOG non-shock, 150 psi at 365°F saturated steam or Class 300 designed for 740 psi WOG non-shock, full port, split body, raised face flange, with blowout proof stem conforming to ANSI/ASME B16.34, ANSI/ASME B16.10, ANSI/ASME B16.5, MSS SP-25 and MSS SP-72

   b. Body: ASTM A216 GR WCB Carbon Steal.

   c. Stem: Stainless steel Type 316 ASTM A276.

   d. Ball: Stainless steel Type 316 ASTM A276.

   e. Seats and Seals Stem Packing and Thrust Washer: PTFE/RPTFE.

   f. Handle: Lever for valves below 6" and gear operators for 6" through 12".

   g. Adjustable stem packing (graphite).

   h. Acceptable Makes: Milwaukee F20CS, Nibco F-515-CS-F-66-FS (Class 150) or F-535-CS-F-66-FS (Class 300), Jamesbury 9150 (Class 150) or 9300 (Class 300), Apollo 87A-200 Series (Class 150) or 87A-900 (Class 300), Watts G4000 and G4000M1 (Class 125)

E. Valves for Gauges and Instruments – HVAC Systems (Non-Potable Water Systems):

   1. Ball valve ½" in size meeting the requirements above for the services specified.

F. Hose Threaded Drain and Manual Vent Valve (Non-Potable Heating Hot Water, Chilled Water, Heating Glycol and Cooling Glycol Systems Operating at a maximum pressure of 125 psi and temperature of 200°F or Below):

1. **DBV-01** - Bronze ½" and ¾" (Threaded and Soldered End Connections)

a. Valve shall be suitable for 400 psi CWP, 2-piece, full port ball valve with blowout proof stem, ¾" hose connection.

b. Body: Bronze ASTM B584 or Brass ASTM B283.

c. Stem: Brass ASTM B16, silicon bronze ASTM B371 alloy C69430 or ASTM B99 alloy C65100.

d. Ball: Chrome plated brass ASTM B16 alloy C36000, ASTM B125 alloy C37700 or ASTMB282 alloy C37700.

e. Seats and Seals Stem Packing and Thrust Washer: PTFE and RPTFE.

f. Handle: Zinc-plated carbon steel with vinyl insulator. Provide handle with extended stem on insulated piping. Provide locking lever.

g. Adjustable stem packing.

h. Acceptable Makes: Watts LFFBV-3C-CC (threaded) and LFFBVS-3C-CC (solder), Apollo 70-100-HC (threaded) and 70-200-HC (solder), Milwaukee BA100H (threaded) and BA150H (solder), Nibco T-585-70-HC (threaded) and S-585-70-HC (solder), Hammond 8501H (threaded) and 8511H (solder).

G. Balance Valve:

1. **General:**

a. Where contractor submits "termination kits" with integral balance valve for approval, use does not preclude the need to provide separate equipment isolation valve. Balance valves are not to be used for isolation duty. Provide separate isolation valve in compliance with Exhibit A of this section.

2. **GBV-01** - Globe Type Balancing Valve:

a. Balancing valve and flow meter stations suitable for use on heating and cooling systems.

b. Maximum Pressure Drop 5.0 Ft. or less.

c. Calibrated balance valve with provisions for connecting a portable differential pressure meter. Meter connections to have built-in check valves.

d. Multi-turn handle for precision adjustment.

e. Balance valve size shall be based upon gpm range rather than pipe size. Select flow balancers such that the range of pipe flow resides in the middle 50% of the manufacturer's recommended operating range for the device.

f. Operating temperature range -4 – 248°F. Suitable for 300psi at 150°F.

g. Brass: Solder or threaded body to match piping system up to 2".

h. Cast Iron: Grooved or flanged bodies to match piping system 2 ½ - 12".

i. Acceptable Makes: Armstrong CBV, Tour & Anderson 780 Series, Griswold "Speedset", Macon STV

3.0 PART 3 – EXECUTION

3.1 INSTALLATION

A. General:

1. Provide valves of type called for and where required to service equipment.

2. Provide at major building and system sections.

3. Provide chain wheels, guides, and chain loops for valves, where called for or in Mechanical Rooms where valves are mounted higher than 8'-0" AFF.

4. Isolating valves for individual fan convectors, room units, terminal units, or other similar apparatus may be inside cabinet or at connection to branch main where accessible.

5. Locate valves with stems at or above horizontal positions and swing check valves in horizontal position only.

6. Provide hose threaded drain valves at all piping system low points, strainers, equipment, and as called for heating hot water systems, chilled water systems, glycol heating systems and glycol cooling systems operating at or below 125 psi and 200°F. Drain or blowdown valves for water and glycol systems operating above 125 psi and 200°F, and steam systems shall be provided with valves specified in Exhibit 'A'. Provide Cap or plug at valve discharge.

B. Install self-regulating flow control valves as recommended by manufacturer. All flow control valves shall have strainer upstream of valve. Strainer shall be as specified in part 2 – Self Regulating Flow Control Valves.

C. Balance Valves:

1. Provide on zone or riser returns, on each hydronic unit and where called for. Meter connection points shall not point downward.

2. Install device in pipe line per manufacturer's instructions for upstream and downstream distances.

3.2 VALVE SELECTION

A. Provide valve types for the specific services as specified in Exhibit 'A'. Valve changes shall be made only as reviewed by Owner's Representative.

EXHIBIT - 'A' - VALVE TYPE (HVAC)

Notes are at the end of Exhibit 'A'

Service	**Check**	**Ball**	**Balancing**	**Special Purpose, Drains and Manual Air Vents**	**Notes**
Hot water heating operating at 125 psi or below	CV-01 Class 125and CV-03 Class 125	BV-03,	GBV-01	DBV-01	Note 1,2,3
Hot water heating operating at 125 psi or below	CV-01 Class 125 and CV-03 Class 125	BV-03 and BV-08 Class 150	GBV-01	DBV-01	Note 1, 2
Glycol chilled water and Chilled water operating at 125 psi or below	CV-01 Class 125and CV-03 Class 125	BV-03,	GBV-01	DBV-01	Note 1, 2
Glycol chilled water and Chilled water operating at 125 psi or below	CV-01 Class 125 and CV-03 Class 125	BV-03 and BV-08 Class 150	GBV-01	DBV-01	Note 1, 2
Domestic water		BV-01			

NOTES FOR EXHIBIT "A":

NOTE 1: Hose threaded drain and vent valves DBV-01 shall only be used on heating hot water, chilled water, glycol heating and glycol cooling systems operating pressure at or below 125 psi and temperature at or below 200°F. Systems operating pressure above 125 psi and operating temperature above 200°F, or sizes above ¾" shall be provided with the listed service valve with the open end of the valve provided with a threaded plug or cap.

NOTE 2: Where options are indicated for the valve connection types (threaded, soldered or welded) in this specification section, refer to Specification Section 232000 for the specific requirement for the connection type for the intended service.

END OF SECTION 230523

SECTION 230550 – WIND RESTRAINT FOR HVAC SYSTEMS

1.0 PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SECTION INCLUDES

A. Support and brace mechanical and electrical systems, as called for, to resist directional wind forces (lateral, longitudinal and vertical) for components attached to curbs and for curbs attached to structure.

1.3 APPLICABLE CODES AND STANDARDS

A. Provide work in compliance with the following codes and standards.

B. Building Code of New York State, Section 1603.

C. Mechanical Code of New York, Section 301.

D. American Society of Civil Engineers (ASCE) Minimum Design Loads for Buildings and Other Structures – Standard ASCE/SEI 7-10.

1.4 QUALITY ASSURANCE

A. General:

1. The contractor shall provide calculations and details of wind restraint systems to meet total design lateral force requirements for support and restraint of mechanical and electrical systems, sealed and signed sealed by a New York registered Professional Engineer.

2. Systems requiring wind restraint:

a. 237313 - Air Handling Units

b. 236213 - Air Cooled Condensing Units

c. 233000 - Sheetmetal and Ductwork Accessories

d. 232000 - Piping Systems and Accessories

e. 233400 – Fans

f. 237219 - Air to Air Energy Recovery Equipment

g. 233726 - Louvers and Penthouses

1.5 SUBMITTTALS

A. Submit wind force level (Fp) calculations for applicable building code. Submit pre-approved restraint selections, installation details, and plans indicating locations of restraints.

B. Calculations, plans, restraint selection, and installation details shall be signed and sealed by a professional engineer licensed in the State of New York and experienced in wind restraint design.

C. Submit manufacturer's product data.

D. For each piece of equipment that requires wind restraint as outlined in this section, include the following:

1. Dimensioned Outline Drawings of Equipment Unit: Identify the center of gravity and locate and describe mounting and anchoring provisions.

2. Anchorage: Provide detailed description of equipment anchorage devices on which the calculations are based and their installation requirements. Identify anchor bolts, studs and other mounting devices. Provide information on the size, type and spacing of mounting brackets, holes and other provisions.

2.0 PART 2 – PRODUCTS

2.1 CODE INFORMATION

A. This project is subject to the wind bracing requirements of the Building Code of New York State, International Building Code and American Society of Civil Engineers ASCE 7. The following criteria are applicable to this project, see Structural Engineering plans for data.

1. Basic Wind Speed (V) (Per ASCE 7-10).

2. Importance Factor (I) (Per ASCE 7-10).

3. Exposure Category (Per ASCE 7-10).

4. Height and Exposure Adjustment Coefficient (Per ASCE 7-05).

5. The mean height of the structure (h_{mean}) shall be determined thru coordination with Architectural plans and the General Contractor.

2.2 WIND BRACING AND SUPPORT OF SYSTEMS AND COMPONENTS

A. General:

1. Design analysis shall include calculated dead loads, wind loads, and capacity of materials utilized for the connection of the equipment or system to the structure.

2. Analysis shall detail anchoring methods, bolt diameter, and embedment depth.

3. All wind restraint devices shall be designed to accept without failure the forces calculated per the applicable building code and as summarized in Section 2.1.

B. Friction from gravity loads shall not be considered resistance to wind forces.

3.0 PART 3 – EXECUTION

3.1 INSTALLATION

A. Wind Restraint of Piping:

1. All restraint systems shall be installed in strict accordance with the manufacturer's restraint guidelines and all certified data.

2. Installation of restraints shall not cause any change in position of equipment or piping, resulting in stresses or misalignment.

3. Transverse piping restraints shall be at 40-foot maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.

4. Longitudinal restraints shall be at 80-foot maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.

5. Transverse restraint for one pipe section may also act as a longitudinal restraint for a pipe section of the same size connected perpendicular to it if the restraint is installed within 24 inches of the elbow or ice or combined stresses are within allowable limits at longer distances.

6. Hold down clamps must be used to attach pipe to all trapeze members before applying restraints.

7. Branch Lines may not be used to restrain main lines.

8. Provide reinforced clevis bolts when required.

9. Piping crossing building seismic or expansion joints, passing from building to building, or supported from different portions of the building shall be installed to allow differential support displacements without damaging the pipe, equipment connections, or support connections. Pipe offset, loops, anchors and guides shall be installed as required to provide specified motion capability and limit motion of adjacent piping.

10. Do not brace a system to two independent structures such as roof and wall.

B. Wind Restraint of Electrical Services:

1. All restraint systems shall be installed in strict accordance with the manufacturer's restraint guidelines manual and all certified data.

2. Installation of restraints shall not cause any change in position of equipment or piping, resulting in stresses or misalignment.

3. No ridged connections between equipment and the building structure shall be made that degrade the noise and vibration-isolation system specified.

4. Do not install any equipment, piping, duct or conduit that makes rigid connections with the building unless isolation is not specified.

5. Prior to installation, bring to the Architect's/Engineer's attention any discrepancies between the specifications and the field conditions, or changes required due to specific equipment selection.

6. Bracing may occur from flanges of structural beams, upper truss cords of bar joists, cast in place inserts, or wedge-type concrete anchors. Consult Structural Engineer of record.

7. Overstressing of the building structure shall not occur from overhead support of equipment. Bracing attached to structural members may present additional stresses. The Contractor shall submit loads to the structural engineer of record for approval in this event.

8. Brace support rods when necessary to accept compressive loads. Welding of compressive braces to the vertical support rods is not acceptable.

9. Provide reinforced clevis bolts where required.

10. Do not brace a system to two independent structures such as a roof and wall.

C. Wind Restraint of Ductwork and Equipment:

1. All restraint systems shall be installed in strict accordance with the manufacturer's restraint guidelines and all certified submittal data.

2. The interaction between mechanical and electrical equipment and the supporting structures shall be designed into the restraint systems.

3. Friction clips shall not be used for anchorage attachments.

4. Expansion anchors shall not be used for non-vibration isolated equipment rated over 10HP.

5. Components mounted on vibration isolation systems shall have a bumper restraint or snubber in each horizontal direction and vertical restraints shall be provided to resist overturning.

6. Installation of restraints shall not cause any change in position of equipment or ductwork, resulting in stresses or misalignment.

7. No ridged connections between equipment and the building structure shall be made that degrade the noise and vibration-isolation system specified.

8. Do not install any equipment or duct that makes rigid connections with the building unless isolation is not specified.

9. Prior to installation, bring to the Architect's/Engineer's attention any discrepancies between the specifications and the field conditions, or changes required due to specific equipment selection.

10. Bracing may occur from flanges of structural means, upper truss cords of bar joists, cast in place inserts, or wedge-type concrete anchors. Consult Structural Engineer of record.

11. Overstressing, of the building structure shall not occur from overhead support of equipment. Bracing attached to structural members may present additional stresses. The Contractor shall submit loads to the Structural Engineer of record for approval in this event.

12. Brace support roads when necessary to accept compressive loads. Welding of compressive braces to the vertical support rods is not acceptable.

13. Provide reinforced clevis bolts where required.

14. Do not brace a system to two independent structures such as a roof and wall.

END OF SECTION 230550

SECTION 230553 - MECHANICAL IDENTIFICATION

1.0 PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services as required for the complete installation designed in Contract Documents.

1.2 QUALIFICATIONS

A. All identification devices shall comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles.

1.3 SUBMITTALS

A. Prior to Ordering Products: Submit manufacturer's technical product data and installation instructions for each identification material and device. For valve tags include proposed tag methodology, including code number, location and valve function. For piping systems and equipment submit proposed schedule of pipe, equipment and name identification for review and approval. Confirm naming / numbering is consistent with any Owner’s naming / numbering convention.

B. As-built submission – Provide final valve schedule for each piping system in both 8-1/2 in. X 11 in. (minimum) and WORD format, indicating code number, location and valve function.

1.4 MAKES

A. Allen Systems, Inc., Brady (W.H.) Co.; Signmark Div., Industrial Safety Supply Co., Inc., Seton Name Plate Corp., Marking Services Incorporated, or approved equal.

2.0 PART 2 - PRODUCTS

2.1 GENERAL

A. Provide manufacturer's standard products of categories and types required for each application. In cases where there is more than one type specified for an application, selection is installer's option, but provide single selection for each product category.

2.2 PIPING IDENTIFICATION

A. Identification Types:

1. Snap-on type: Provide manufacturer's standard pre-printed, semi-rigid snap-on, color coded pipe markers, complying with ANSI/ASME A13.1.

2. Stencil paint: Apply black or yellow stencil paint directly to covering or bare pipe; color to contrast with background. Stencil as follows:

Pipe or Covering	Size Stencil Letter
½", ¾", 1", 1-1/4"	1/2"
1-1/2", 2"	3/4"
2 ½" and over	1"

B. Lettering:

1. Piping labeling shall conform to the following list:

Pipe Function	Identification
Pumped Condensate	PC
Cold Water (Domestic Water)	CW
Heating Water Supply	HWS
Heating Water Return	HWR
Chilled Water Supply	CWS
Chilled Water Return	CWR
Refrigerant	R
Refrigerant (A2L Safety Class)	R-A2L
Vent	V
Overflow	OF
Drain	D
Natural Gas	NG

2. Refer to paragraph 3.2 for special requirements for refrigerant pipe identification.

2.3 VALVE IDENTIFICATION

A. Valve Tags:

1. Standard brass valve tags, 2" diameter with 1/2" high numerals. Identify between heating and plumbing services with 1/4" letters above the valve number.

2. Equal to Seton Style 300 Cat.

B. Valve Chart:

1. Provide valve chart for all valves provided as a part of this project. Frame and place under clear glass. Hang in Mechanical Room.

C. Identification of Refrigeration System Stop Valves, systems containing more than 6.6# of refrigerant:

1. Stop valves shall be labeled if the components regulated by the valve are not in view at the valve location. Numbering or lettering labels shall be a minimum of 0.50 in. (12.7 mm) in height. When valve numbering or lettering systems are used, the key shall be located in accordance with the requirements of the AHJ.

2.4 EQUIPMENT IDENTIFICATION

A. General:

1. Provide engraved acrylic or vinyl plates for each major piece of mechanical equipment provided.

2. Nameplates: 3/4" x 2-1/2" equal to Seton Cat. #2060-20.

3. Provide for the following equipment:

a. Air handling units

b. Fans

c. Pumps

d. Condensate pumps

e. Air conditioners

f. Energy recovery units

g. Fan coil units

h. Unit heaters/cabinet heaters

i. Filters

j. Duct coils

k. Fire dampers

l. Smoke dampers

2.5 DUCTWORK IDENTIFICATION

A. Identification Types:

1. Stencil paint: Apply black or yellow stencil paint directly to insulation or bare sheetmetal; color to contrast with background. Stencil as follows: 2” Stencil Letters.

2. Provide arrow indicating direction of airflow.

3. Label outside air ducts with the outside air minimum CFM rate.

4. Label supply air duct main at air handling unit discharge with the unit maximum CFM rate.

B. Lettering:

1. Ductwork labeling shall conform to the following list:

Duct Function	Identification
Return Ductwork	RA
Relief Ductwork	REA
Exhaust Ductwork	EA
Supply Ductwork	SA
Outside Air Ductwork	OA

3.0 PART 3 - EXECUTION

3.1 GENERAL

A. Provide valve tags for all valves provided on project.

B. Provide equipment tags for all equipment listed in Equipment Identification Section above.

C. Provide piping identification with directional flow arrows for all piping on project. Maximum every 10’-0”. Provide tags on piping at all coil terminations. For piping installed through rooms, provide at least one pipe label in each room, for each pipe function.

D. Provide Ductwork identification with directional arrows for all ductwork on project. Maximum every 10'-0”. Provide at least one duct label in each room for each duct function.

3.2 SPECIAL REQUIREMENTS – REFRIGERANT PIPING IDENTIFICATION

A. Refrigerant piping located in areas other than the room or space where the refrigerating equipment is located shall be identified in accordance with ANSI/ASME A13.1. The pipe identification shall be located at intervals not exceeding 20 ft (6.1 m) on the refrigerant piping or pipe insulation, and at least once within each room / compartment through which it is routed. The minimum height of lettering of the identification label shall be 0.50 in. (12.7 mm). The identification shall indicate the refrigerant designation and safety group classification of refrigerant used in the piping system.

B. For Group A2L and B2L refrigerants, the identification shall also include the following statement: “WARNING—Risk of Fire. Flammable Refrigerant.”

C. For Group A2, A3, B2, and B3 refrigerants the identification shall also include the following statement: “DANGER— Risk of Fire or Explosion. Flammable Refrigerant.”

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING AND BALANCING

1.0 PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All work under this section is subject to the Contract Documents and this Contractor shall be responsible for and governed by all the requirements therein.

B. This Contractor shall reference the entirety of Divisions 22 and 23 as they apply to this work.

C. Refer to specification Section 019113 for commissioning requirements related to this project.

1.2 SUMMARY

A. Provide labor, materials, equipment and services to perform operations required for testing, adjusting, and balancing HVAC systems to produce design objectives, including, but not limited to the following:

1. Pre-demolition testing of existing systems.

2. Balancing airflow and water flow within distribution systems, including submains, branches, and terminals, to indicated quantities according to specified tolerances.

3. Adjusting total HVAC systems to provide indicated quantities.

4. Measuring electrical performance of HVAC equipment.

5. Setting quantitative performance of HVAC equipment.

6. Verifying that automatic control devices are functioning properly.

7. Calibration of flow (air and water) sensors provided by the 230923 contractor

8. Reporting results of the activities and procedures specified in this Section.

1.3 SUBMITTALS

A. Quality-Assurance Submittals: Submit copies of evidence that the Testing, Adjusting, and Balancing contractor and this Project's testing, adjusting, and balancing team members meet the qualifications specified in the "Quality Assurance" article below.

B. Sample Report Forms: Submit required number of sets of sample testing, adjusting, and balancing report forms.

C. TAB Strategies and Procedures Plan: Within 60 days from the Contractor's Notice to Proceed, submit 2 copies of the testing, adjusting, and balancing strategies and step-by-step procedures as specified in "Preparation" article below. Include a complete set of report forms intended for use on this Project with each copy. Included in this plan shall be a thorough description of means and methods pertaining to maintenance of systems balance in detailed coordination with all phasing requirements for this project

D. Certified Testing, Adjusting, and Balancing Reports: Submit required number of copies of reports prepared, as specified in the Submission of Certified Balance Reports Section, on approved forms certified by the registered contractor; include registration number.

E. Warranty: Submit required number of copies of the warranty specified in the "Warranty" Article below.

1.4 QUALITY ASSURANCE

A. Agent Qualifications: Engage a testing, adjusting, and balancing contractor certified/registered by the Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB). Contractor shall have performed as a member in good standing with recognized procedures for no less than five (5) years including projects of the magnitude and design of this project. Balancing Contractor must be approved by the Engineer. See Section 1.3.

B. Certification of Testing, Adjusting, and Balancing Reports: Certify the testing, adjusting, and balancing field data reports. This certification includes the following:

1. Review field data reports to validate accuracy of data and to prepare certified testing, adjusting, and balancing reports.

2. Certify that the testing, adjusting, and balancing team complied with the approved testing, adjusting, and balancing plan and the procedures specified and referenced in this Specification.

C. Testing, Adjusting, and Balancing Reports: Use standard forms from AABC or NEBB's Standards for Testing, Adjusting, and Balancing, or approved equal.

D. Instrumentation Type, Quantity, and Accuracy: As described in AABC or NEBB national standards.

E. Instrumentation Calibration: Calibrate instruments at least every 6 months or more frequently if required by the instrument manufacturer.

1.5 PROJECT CONDITIONS

A. The Owner may occupy all or part of the site and existing building during the entire testing, adjusting, and balancing period as required. Cooperate with the Owner during testing, adjusting, and balancing operations to minimize conflicts with the Owner's operations. It is the intent to have all possible balancing procedures complete prior to any Owner occupancy. Contractor shall perform the necessary work in an expedient and accurate manner which best serves the need of verifying proper installation and operation of the installed systems and allowing prompt Owner occupancy.

1.6 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls contractor, and other mechanics to operate HVAC systems and equipment to support and assist testing, adjusting, and balancing activities.

B. Coordinate TAB activities with temperature control system setup and calibration

1.7 WARRANTY

A. General Warranty: The national project performance guarantee 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 this Contractor under requirements of the Contract Documents.

B. NEBB will assist in completing the requirements of the Contract Documents if the testing, adjusting, and balancing contractor fails to comply with the Contract Documents. Guarantee shall include the following provisions:

1. The certified contractor has tested and balanced systems according to the Contract Documents.

2. Systems are balanced to optimum performance capabilities within design and installation limits.

3. Copy of the performance guarantee shall be included in each final certified air balance report.

2.0 PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Provide all required instrumentation and tools, including, but not limited to ladders, recording meters, gauges, thermometers, voltmeters, anemometers, Pitot tubes, inclined gauge manometers, magnehelic gauges, amprobes, voltmeters, psychrometers and tachometers. Instruments used shall be accurately calibrated as per AABC or NEBB requirements

3.0 PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are located as required in the Contract Documents and installed per manufacturer's requirements. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operations. All deficiencies shall be reported to the Engineer in writing within 60 days from award of contract. Failure to provide notice within this time period may require that any devices required for proper balance of these systems be installed at the cost of this contractor.

B. Examine approved submittal data of all HVAC systems and equipment.

C. Examine equipment performance data, including fan and pump curves. Relate performance data to project conditions and requirements, including system effects that can create undesired or unpredicted conditions and/or cause reduced capacities in all or part of a system. Calculate system effect factors to reduce the performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems"; or in SMACNA's "HVAC Systems-Duct Design". Compare this data with the design data and installed conditions.

D. Examine system and equipment installations to verify that they are complete and ready for testing.

E. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as balancing valves and fittings, and manual volume dampers, are properly installed, and their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

F. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing. Any noted deficiencies should be reported immediately to the Engineer for further action.

G. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.

H. Examine strainers for clean screens, removal of startup screens and proper perforations.

I. Examine 3-way valves for proper installation for their intended function of diverting or mixing fluid flows.

J. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

K. Examine equipment for installation and for properly operating safety interlocks and controls.

L. Examine automatic temperature control system components to verify the following:

1. Dampers, valves, and other controlled devices operate by the intended controller.

2. Dampers and valves are in the position indicated by the controller.

3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multi-zone units, mixing boxes, and variable-air-volume terminals.

4. Automatic modulating and shutoff valves are properly connected.

5. Temperature sensors are located to avoid adverse effects of sunlight, drafts, and cold walls. Sensors are located to sense only the intended conditions.

6. Sequence of operation for control modes is according to the Contract Documents.

7. Controller set points are set at design values. Observe and record system reactions to changes in conditions. Record default set points if different from design values.

8. Interlocked systems are operating.

9. Changeover from heating to cooling mode occurs according to design values.

M. Report deficiencies discovered before and during performance of testing, adjusting, and balancing procedures immediately to the Engineer for further action.

3.2 PREPARATION

A. Complete system readiness checks and prepare system readiness reports. Verify the following:

1. Permanent electrical power wiring is complete. Equipment rotation has been checked.

2. Hydronic systems are filled, clean, strainers cleaned, startup screens removed and system free of air.

3. Automatic temperature control systems are operational.

4. Equipment and duct access doors are securely closed.

5. Balance, smoke, and fire dampers are open.

6. Isolating and balancing valves are open and control valves are operational.

7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices has been provided.

8. Filters are clean and in place, including pre-filters and final filters where applicable.

3.3 GENERAL TESTING AND BALANCING PROCEDURES

A. All systems shall be tested and verified to be in compliance with the performance characteristics contained in the contract documents. All testing shall be performed in compliance with the requirements of NEBB or AABC Standards for Testing and Balancing, or within the standards described in this section. The more stringent standard shall apply.

B. Adjusting and balancing shall be accomplished as soon as the systems are completed to the extent required to allow the work to proceed, and before the Owner takes possession. Verify that the system is properly vented, cleaned, and strainers are cleared with startup mesh removed prior to balance.

C. Cut insulation, ducts, and pipes for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to the Insulation Specifications for this Project.

D. Mark equipment settings with paint or other suitable, permanent identification material, including damper-control positions, valve indicators, fan speed control levers, and similar controls and devices, indicating final settings.

E. Adjusting and balancing shall be accomplished under appropriate outdoor temperature conditions. All outdoor conditions (Db, Wb, and a description of the weather conditions) at the time of testing shall be documented in the report.

F. Identify flow balancers and dampers in systems which cannot be manipulated to satisfy balancing requirements. Return to site after remedial actions are performed to adjust corrected systems.

G. Traverse duct mains to determine total air system delivery quantities after all outlets have been set and, if necessary prior to final adjustment if the system does not meet design requirements. A sum of room CFM's is not acceptable.

3.4 FUNDAMENTAL AIR SYSTEM BALANCING PROCEDURES

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross check the summation of required outlet volumes with required fan total volume.

1. Determine system diversity factors. Prepare plan to simulate system diversity

2. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

3. Check the airflow patterns from the outside air louvers and dampers and the return and exhaust air dampers, through the supply fan discharge and mixing dampers.

4. Locate start-stop and disconnect switches, electric interlocks, and motor starters.

5. Verify that motor starters are equipped with properly sized thermal protection.

6. Check dampers for proper position to achieve desired airflow path.

7. Check for airflow blockages.

8. Check condensate drains for proper connections and function.

9. Check for proper sealing of air-handling unit components

B. Air System Balancing Procedures:

1. The procedures in this article apply to all supply, return, and exhaust air systems. Additional procedures are required for variable air volume systems; these additional procedures are specified in the following articles in this specification.

2. Adjust fans to deliver total design air flows within the maximum allowable speed (rpm) listed by the fan manufacturer.

3. Measure fan static pressures to determine actual static pressure as follows:

   a. Measure outlet static pressure as far downstream from the fan as practicable 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 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.

4. Measure static pressure across each air-handling unit component.

5. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions in the event that adverse resulting conditions occur which make the system unable to achieve design performance levels.

6. Adjust fan speed higher or lower as required to meet as installed conditions. Provide new sheaves as required. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan speed changes.

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 no overload will occur. Measure amperage in full cooling, full heating, and economizer modes to determine the maximum required brake horsepower.

8. Adjust volume dampers for main duct, submain ducts, and major branch ducts to design air flows within specified tolerances.

    a. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved. Where sufficient space in submains and branch ducts is unavailable for pitot tube traverse measurements, measure air flow at terminal outlets and inlets and calculate the total air flow for that zone.

    b. Re-measure each submain and branch duct after all have been adjusted. Continue to adjust submains and branch ducts to design air flows within specified tolerances.

9. Measure terminal outlets and inlets without making adjustments. Measure terminal outlets using a direct reading hood or the outlet manufacturer's written instructions and calculating factors.

10. Adjust terminal outlets and inlets for each space to within +/- 10% of design airflow. Make adjustments using volume dampers rather than the dampers at the air terminals, where available.

    a. Adjust each outlet in the same room or space to within specified tolerances of design quantities without generating noise levels above the limitations prescribed by the Contract Documents.

    b. Adjust patterns of adjustable outlets for proper distribution without drafts.

    c. Where pressure gradients are required between spaces, provide adjustment of supply and return / exhaust air such that the supply vs return / exhaust rate shown on the plan is maintained.

    d. Record final air volume and air flow pattern for each inlet and outlet.

3.5 FUNDAMENTAL 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 approved pump flow rate. Correct variations that exceed plus or minus 5%.

B. Verify that systems are prepared for hydronic systems 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 flow control valves for specified sequence of operation and set at design flow.

3. 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.

C. Hydronic System Balancing Procedures:

1. Set calibrated balancing valves, if installed, at calculated pre-settings.

2. Measure flow at all stations and adjust, where necessary, to obtain first balance.

a. System components that have C_V rating or an accurately cataloged flow pressure drop relationship may be used as a flow indicating device.

3. Measure flow at main balancing station and set main balancing device to achieve flow that is 5% greater than design flow. Where pump selection provides a firm operating point, pump flow may be derived from the pump curve in lieu of the balancing device.

4. Adjust balancing stations to within specified tolerances of design flow rate as follows:

a. Determine the balancing station with the highest percentage over design flow.

b. Adjust each station in turn, beginning with the station with the highest percentage over design flow and proceeding to the station with the lowest percentage over design flow.

c. Record settings and mark balancing devices.

5. Measure the differential pressure control valve settings existing at the conclusion of balancing.

3.6 MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data as it applies.

1. Manufacturer, model, frame and serial numbers.

2. Complete nameplate data.

3. Efficiency rating if high efficiency motor.

4. Measured voltage and amperage, each phase

5. Starter thermal protection element rating.

3.7 HEAT TRANSFER COILS

A. Hydronic: Measure the following data for each coil.

1. System identification.

2. Location.

3. Coil Type and nameplate data

4. Dry-bulb temperatures of entering and leaving air.

5. For cooling coils – record entering %RH or wet bulb data.

6. For primary coils (Air Handlers, etc.) – Record face velocity and air pressure drop.

7. Record airflow rate

8. Adjust water flow rate as scheduled

9. Adjust bypass water flow on three-way circuits for 50% of total coil water flow scheduled.

3.8 TEMPERATURE CONTROL VERIFICATION

A. Verify that all control devices are calibrated and fully operational.

B. Check transmitter and controller locations and note conditions that would adversely affect control functions.

C. Record controller settings and note variances between set points and actual measurements.

D. Verify free travel and proper operation of control devices such as damper and valve operators.

3.9 TOLERANCES

A. Unless noted to the contrary in other portions of the contract documents, set HVAC system airflow and waterflow rates within the following tolerances.

1. Supply, Return, and Exhaust, Air Inlets and Outlets: +/- 10%, maintaining required pressure balance between adjacent spaces / zones.

2. Fans at +/- 5% of delivery requirements.

3. Water-Flow Rates: +/- 5%.

3.10 FINAL REPORT

A. General: Computer printout in letter quality font, on standard bond paper. Provide 1 hard copy in 3-ring binder, tabulated and divided into sections by tested and balanced systems. Provide PDF copy for project record.

B. A certification sheet in front of binder signed and sealed by the certified testing and balancing agent. All reports shall bear the seal of the certifying agent for the balancing contractor. Include a list of the instruments used for procedures, along with proof of calibration.

C. Final Report Contents: Final report shall consolidate data from all segments of phased project. In addition to the certified field report data, include the following:

1. Fan curves.

2. Pump 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 approved Shop Drawings and Product Data.

D. General Report Data: In addition to the form titles and entries, include the following data in the final report, as applicable:

1. Title page including:

   a. Name and address of testing, adjusting, and balancing contractor.

   b. Project name.

   c. Project location.

   d. Architect's name and address.

   e. Engineer's name and address.

   f. Contractor's name and address.

   g. Report date

2. Signature of testing, adjusting, and balancing agent who certifies the report.

3. Summary of contents, including the following:

   a. Design versus final performance.

   b. Notable characteristics of systems.

   c. Description of system operation sequence if it varies from the Contract Documents.

4. Nomenclature sheets for each item of equipment.

5. Data for terminal units, including manufacturer, type, size, and fittings.

6. Report shall document all information items requested within this specification section.

E. System Diagrams: On complete set of reproducible contract drawings provide single line sketch of system (designer – one or the other) marked up with terminal unit numbers, room numbers, test locations, register, grill, and diffuser numbers to correlate with test sheet. Include the following:

1. Quantities of outside, supply, return, and relief/exhaust airflow.

2. Water flow rates.

3. Pipe and valve sizes and locations.

4. Terminal units.

5. Balancing stations.

F. Fan Test Reports: In addition to other requirements for supply, return, and exhaust fans, include the following:

1. Fan Data: Include the following:

a. System identification.

b. Location.

c. Make and type.

d. Model number and size.

e. Manufacturer's serial number.

f. Arrangements and class.

g. Fan and motor sheave make, size in inches, bore, and key size.

h. Fan and motor sheave dimensions, center-to-center and amount of adjustment in inches.

i. Number of belts, manufacturer, and size

2. Test Data: Include design and actual values for the following:

a. Total airflow rate in cfm.

b. Total system static pressure in inches wg.

c. Fan rpm.

d. Discharge static pressure in inches wg.

e. Suction static pressure in inches wg.

f. Motor data.

G. Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record and report the following data as a minimum:

1. System and air handling unit number.
2. Location and zone.
3. Traverse air temperature in °F.
4. Duct static pressure in inches wg.
5. Duct size in inches.
6. Duct area in sq. ft.
7. Design airflow rate in cfm.
8. Design velocity in fpm.
9. Actual airflow rate in cfm.
10. Actual average velocity in fpm.

H. Air Terminal Unit Reports: In addition to other requirements for terminal units, include the following:

1. Unit Data: Include the following:
   a. System and air handling unit identification.
   b. Location and zone.
   c. Test apparatus used.
   d. Area served.
   e. Air terminal make.
   f. Air terminal number from system diagram.
   g. Air terminal type and model number.
   h. Air terminal size.
2. Test Data: Include design and actual values for the following:
   a. Airflow rate in cfm (minimum and maximum).
   b. Preliminary airflow rate as needed in cfm.
   c. Final airflow rate in cfm.

d. Space temperature in °F.

e. Duct Supply Air Temperature in °F.

I. Instrument Calibration Reports: For instrument calibration, include the following data in report, as a minimum:

1. Instrument type and make.

2. Serial number.

3. Application.

4. Dates of use.

5. Date of calibration.

3.11 ADDITIONAL TESTS

A. Balance Contractor shall be prepared to verify the balance of select devices in the presence of the Engineer and / or Commissioning Authority at their discretion. This typically will require only a few hours to a day of labor, depending on the project scope. If, in the opinion of the Engineer or Commissioning Authority these verifications contain adequate discrepancies to provide doubt to the accuracy of the balance procedures performed, the Engineer or Commissioning Authority may order additional re-balancing or re-verification until such time as these discrepancies are eliminated throughout the systems; this verification shall be at the Contractor's expense.

B. Seasonal Periods: Initial testing, adjusting, and balancing procedures at start-up will not provide a good representative sample of system performance due to seasonal conditions. Therefore the Contractor shall return at a later time to perform the required balancing work, up to 8 hours of balancing work, to address seasonal conditions. This shall not delay the submittal of the certified balance reports for all work otherwise performed.

3.12 SUBMISSION OF CERTIFIED BALANCE REPORTS

A. Time is of the essence in the completion of this portion of the contract. It is expected that the certified balance reports will be submitted in a timely manner, within thirty (30) days of the work performed. At the completion of the project, it shall be the responsibility of this Contractor to assemble a single certified report and submit 1 printed copy to the Engineer as closeout documentation, along with electronic copy in PDF format.

END OF SECTION 230593

SECTION 230700 - INSULATION

1.0 PART 1 – GENERAL

1.1 WORK INCLUDED

A. All work shall comply with the requirements of the 2020 Energy Construction Conservation Code of New York State, manufacturer's requirements for installation and these specifications. In the event of conflicts between these documents, the more stringent requirements shall govern.

B. Provide labor, materials, equipment and services to perform operations required for the complete installation and related work as required in the Contract Documents. The extent of insulation work is indicated on the drawings and by the requirements of this section.

C. Repair all insulation at points of piping and ductwork system tie in to existing and at locations where existing systems are cut, patched or capped.

D. Insulate all existing piping systems, ductwork systems and equipment after removal of existing insulation whether by this contractor or another, including but not limited to removal of asbestos products.

E. Remove existing insulation where indicated on the drawings or specified here-in.

1.2 SUBMITTALS

A. Manufacturers' Data. Submit manufacturer's data and installation instructions.

B. Schedule of insulation applications.

C. Certification: Provide certifications as necessary to show compliance with these specifications and governing regulations. Include proof of compliance for test of products for fire rating, corrosiveness, and compressive strength.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Section 232000 – Piping Systems and Accessories.

B. Section 232133 – Water Systems Specialties.

C. Section 233000 – Sheet Metal and Ductwork Accessories.

2.0 PART 2 – PRODUCTS

2.1 GENERAL

A. Insulation, Jackets, Adhesives, and Coatings, shall comply with the following:

1. Treatment of jackets or facings for flame and smoke safety must be permanent. Water soluble treatments are not permitted.

2. Insulation, including finishes and adhesives on the exterior surfaces of ducts, pipes, and equipment, shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less, as tested by ASTM E84 (NFPA 255) and UL 723 methods, using the specimen preparation and mounting procedures of ASTM E2231.

3. Insulation within plenums, duct coverings and duct linings shall not flame, glow, smolder or smoke when tested in accordance with ASTM C411 at the temperature to which they are exposed in service. The test temperature shall not fall below 250°F. Pipe and duct insulation shall be listed and labeled.

4. All adhesives, coatings and sealants used for the insulation shall comply with the maximum Volatile Organic Compound (VOM) limits as called for in the current version of U.S. Green Building Council LEED Credits.

5. Provide materials which are standard insulation products of manufacturers for piping, ductwork and equipment systems.

6. Provide insulation in accordance of MICA and NAIMA standards.

7. Asbestos or asbestos bearing materials are prohibited.

8. Ducts operating at temperatures above 120 degrees shall have sufficient thermal insulation to limit the exposed surface temperature to 75 degrees.

9. The insulation shall be clearly labelled by the manufacturer with the installed thermal “R” values in accordance to the Energy Conservation Code.

10. UL GREENGUARD Gold Certification – all insulation materials shall be GREENGUARD certified, documentation for which shall be contained in the paragraph 1.2.c submittal information.

2.2 ACCEPTABLE MANUFACTURERS

A. Fiberglass: Knauf, Manville, Owen-Corning, Certainteed.

B. Polyisocyanurate: Dow Trymer 2000XP, HyTherm.

C. Flexible Elastomeric: Armstrong, Rubatex International, Armacell

D. Calcium Silicate: Industrial Insulation Group (IIG), Johns Manville, Owens-Corning.

E. Removable Thermal Blanket: Insultech, Shannon, Irwin.

F. Adhesives, Coatings, Mastics, Sealants: Childers, Foster, Armacell.

G. Aluminum Jacket Material: GIC, GLT, RPR.

H. Laminated Rubberized Bitumen Jacket: Alumaguard, VentureClad, Flex Clad.

I. Pre-Molded PVC Fitting Covers: Zeston, Proto System

2.3 PIPE INSULATION (RIGID FIBERGLASS TYPE)

A. Glass Fiber insulation meeting ASTM C 547, Type II, Class 2, ASTM C 585, ASTM C 795 and ASTM C 1136; rigid, molded, noncombustible.

B. Minimum 'K' Value: ASTM C 335, 0.23 at 75°F mean temperature installed value. Maximum Service Temperature: 1000°F.

C. Vapor Retarder Jacket: ASJ/SSL conforming to ASTM C 1136 Type I, secured with self-sealing longitudinal laps and butt strips.

D. Field-Applied PVC 30 mil Fitting Covers with Flexible Fiberglass Insulation complying with ASTM C 450 and ASTM C 585: Proto Corporation LoSmoke, UV-resistant fittings and accessories, white or colored. Fitting cover system consists of pre-molded, high-impact PVC materials with blanket type fiberglass wrap inserts. Blanket fiberglass wrap inserts shall have a thermal conductivity ('K') of 0.26 at 75°F mean temperature. Closures to be stainless steel tacks, matching PVC tape, or PVC adhesive per manufacturer's recommendations.

2.4 PIPE INSULATION (FLEXIBLE ELASTOMERIC FOAM)

A. Flexible, elastomeric thermal insulation, with expanded closed-cell foam structure, antimicrobial protection and free of CFC's, HFC's, HCFC's, formaldehyde, fibers and dust, with low VOC's. Maximum water vapor transmission of 0.10 perm-inch based on ASTM E96, Procedure A. Maximum thermal conductivity (k) shall be 0.27 Btu/ft²•hr.• F/in. at 75ºF mean temperature. Fire spread/smoke developed rating of 25/50 or less based on ASTM E84 for up to 2" material thickness. Furnish with self-sealing reinforced lap seal.

B. Pipe Insulation: ASTM C534, Type I.

C. Sheet Insulation for Ductwork and Equipment: ASTM C534, Type II, smooth skin one side.

2.5 PIPE INSULATION TAPES

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

1. Width: 4 inches.

2. Thickness Total: 14.3 mil.

3. Adhesion: 90 ounces force/inch in width.

4. Elongation: 2 percent.

5. Tensile Strength: 40 lbf/inch in width.

B. FSK Tape: Foil face, vapor retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Width: 4 inches.

2. Thickness Total: 13.3 mil.

3. Adhesion: 90 ounces force/inch in width.

4. Elongation: 2 percent.

5. Tensile Strength: 40 lbf/inch in width.

2.6 DUCT INSULATION

A. Duct Liner – Refer to Specification Section 233000.

B. Flexible Fiber Glass Blanket:

1. Insulation Blanket meeting ASTM C 553, Type II, ASTM C 1290, Type III, and ASTM C 1138.

2. 'K' Value of 0.27 at 75°F mean temperature. Maximum Service Temperature (Faced): 250°F.

3. Vapor Retarder Jacket: ASJ conforming to ASTM C 1136 Type I, II, III, IV, VIII or FSK conforming to ASTM C 1136 Type II, IV. Provide ASJ jacket for ductwork to be painted.

4. Installation: Maximum allowable compression is 25%.

5. Density: Minimum 1.0 PCF.

6. For duct wrap, the installed thickness shall be assumed to be 75 percent (25% compression) of nominal thickness.

C. Rigid Fiber Glass Board

1. Insulation Board meeting ASTM C 612 Type IA, IB and II, ASTM C 795 and ASTM C 1138.

2. 'K' Value of 0.23 at 75°F mean temperature. Maximum Service Temperature: 450º F.

3. Vapor Retarder Jacket: ASJ conforming to ASTM C 1136 Type I, or FSK or conforming to ASTM C 1136 Type II, IV. Provide ASJ jacket for ductwork to be painted.

4. Concealed Areas: Minimum 3 lb./ft.^{3}.

5. Exposed Areas: 6 lb./ft.^{3} minimum density for duct less than 8 ft. - 0 in. above finished floor or where indicated in these specifications or on the drawings.

D. Rigid Polyisocyanurate Insulation:

1. Cellular foam complying with ASTM C591, rigid molded, non-combustible. 2 lb./ft^3 nominal density. Maximum thermal conductivity (k) shall be 0.19 BTU-in/ft^2 hr. °F at 75°F mean temperature. Maximum Service Temperature; 300°F.

E. Duct Insulation Tapes:

1. ASJ (All Service Jacket) Tape: White vapor retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

a. Width: 4 inches.

b. Thickness Total: 0.19mm

c. Adhesion: Exceeds strength of tape back.

d. Elongation: 2 percent.

e. Tensile Strength: 40 lbf/inch in width.

f. Make: 3M Venture Tape 1540CW, Owens Corning ASJ Max or approved equal

2. FSK (Foil. Scrim and Kraft Laminate) Tape: Foil face, vapor retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

a. Width: 4 inches.

b. Thickness Total: 5.5 mil.

c. Adhesion: 66 ounces force/inch in width.

d. Elongation: 2 percent.

e. Ambient Limits: -40 to 240 deg F

f. Tensile Strength: 39 lbf/inch in width.

g. Make: Owens Corning Thermafiber. 3M Venture Tape 1525CW, or approved equal.

2.7 EQUIPMENT INSULATION

A. Segmented board, sheets, blocks, size, shape, and material as called for.

B. Rigid Fiber Glass Board

1. Insulation Board meeting ASTM C 1393, Type I, II, IIIA, III B and Category 2, ASTM C 795 ASTM and C 1138.

2. 'K' Value of 0.27 at 75°F mean temperature. Maximum Service Temperature: 650º F.

3. Vapor Retarder Jacket: ASJ conforming to ASTM C 1136 Type I, II, III, IV or FSK conforming to ASTM C 1136 Type II. Provide ASJ jacket for ductwork to be painted.

4. Concealed Areas: Minimum 3 lb./ft.^{3}.

5. Exposed Areas: 6 lb./ft.^{3} minimum density for equipment less than 8 ft. - 0 in. above finished floor or where indicated in these specifications or on the drawings.

C. Flexible Elastimeric Foam:

1. Flexible, elastomeric thermal insulation, with expanded closed-cell foam structure, antimicrobial protection and free of CFC's, HFC's, HCFC's, formaldehyde, fibers and dust, with low VOC's. Maximum water vapor transmission of 0.10 perm-inch based on ASTM E96, Procedure A. Maximum thermal conductivity (k) shall be 0.27 Btu/ft²•hr.• F/in. at 75ºF mean temperature. Fire spread/smoke developed rating of 25/50 or less based on ASTM E84 for up to 2" material thickness.

2. Pipe Insulation: ASTM C534, Type I.

3. Sheet Insulation for equipment: ASTM C534, Type II, smooth skin one side.

2.8 PIPE, DUCT AND EQUIPMENT JACKETING

A. Metal Jacketing Material:

1. Aluminum Jacket: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005, Temper H-14. Sheet and roll stock ready for shop or field sizing. Stucco Embossed: 0.020 inch thickness.

a. Moisture Barrier for Indoor Applications: Minimum 1mil thick, heat bonded polyethylene and kraft paper.

b. Moisture Barrier for Outdoor Applications: Minimum 2.5 mil thick polysurlyn.

2. Factory-Fabricated Fitting Covers:

a. Same material, finish, and thickness as jacket.

b. Preformed 2 piece or gore, 45 and 90 degree, short and long radius elbows covers.

c. Flange and union covers.

d. Tee end caps.

e. Beveled collars.

f. Valve covers.

g. Field-fabricate fitting covers only if factory-fabricated fitting covers are not available. Valve covers.

3. Banding: Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316 equal to the jacketing material, ½ and ¾ inch wide with wing seal. Banding. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005, Temper H-14, 0.020 inch thick, ½ and ¾ inch wide with wing seal.

B. PVC 30 mil Jacket: High impact resistant, UV resistant PVC complying with ASTM D 1784, Class 16354-C. Roll stock ready for shop or field cutting and forming.

1. Color: White

C. Self-Adhesive, Laminated Rubberized Jacket:

1. Multi-ply laminated rubberized bitumen compound system. UV-resistant aluminum foil/polymer or polyester/foil system with acrylic adhesive.

2. 55-60 mil thickness with a low-pressure sensitive adhering system.

3. Stucco-embossed aluminum finish.

2.9 THERMAL BLANKET

A. Thermal Barrier with a maximum service temperature of 450°F.

B. Outer and Inner Jacket, 17 oz./sq. yd. Silicone impregnated Fiberglass cloth.

C. Insulation Material, 11 PCF Fiberglass Needled Mat-Type "E" Fiber.

D. Mat encapsulated by the silicone impregnated Fiberglass cloth and sewn together, producing a self-contained blanket system.

E. Blanket system fasteners for easy install and removal.

F. The insulation cover shall be 2 in. thickness with a K factor of 0.26 at 100°F.

G. Blanket construction shall be double sewn lock stitch with a minimum 7 stitches per inch. All raw jacket edges shall have a tri-fold Silicone Cloth binding. No raw cut jacket edge shall be exposed. Stitching shall be done with PTFE coated fiberglass thread or PTFE Teflon coated Nomex thread.

H. The blanket shall extend beyond mating flanges unto existing insulation for a minimum of 2 in. Where blanket cannot fit over existing oversized insulation, blanket shall butt up to existing insulation with a friction fit closing seam. All sections of pipes shall be insulated, and open gaps are not acceptable. Blanket diameters which are 2 in. or larger than existing insulation must be end capped to eliminate open air void.

I. The blankets shall have a low point stainless steel drain grommet or incorporate a mating seam at the lowest point of the blanket.

J. For large equipment where a multi-piece construction is necessary, the total number of pieces shall be minimized. Any one piece shall not exceed 40 lbs. in weight.

K. Provide an aluminum or 304 type stainless steel nameplate tag riveted to each blanket piece. 1/8 in. embossed lettering shall identify the equipment it is serving, size and pressure rating of the system. Each blanket requires an I.D. Plate.

L. 14-gauge type 304 stainless steel quilting pins shall be placed at random locations no greater than 18 in. apart to prevent shifting of the insulation, 14 gauge type 304 Stainless Steel speed washers shall secure the quilting pin stem in place.

M. Equipment and equipment heads shall be a multi-piece design installed in tag number sequence. Heat exchanger heads, large vessel flanges and pump housings will be designed in two half sections. Blanket design shall conform to the equipment with minimized air void. All valve covers shall be a two-piece design with a separate body and bonnet.

N. A 21-gauge type 304 stainless steel wire shall be doubled up and twisted in a spiral fashion, with a minimum of 4 to 5 twists per inch. Wire twist length shall be 16 in. or longer. The wire twist shall be secured to the lacing pin at the pin stem. Lacing pin stems shall be 14-gauge type 304 stainless steel. Pins shall be held in place with 1 in. diameter type 304 stainless steel speed washers. Wire twists shall be spaced 6 in. on center along closing seams with matching lacing pins to lace and secure to.

O. Alternate fastening systems such as Metal "D" ring strap with Velcro tab, or side release buckles may be utilized.

2.10 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass Fiber Fabric: Approximately 6 oz. /sq. yd. with a thread count of 5 strands by 5 strands/sq. in. for covering ducts and equipment. Childers CHIL-GLAS #5 or equal.

2.11 COATINGS, MASTICS, ADHESIVES AND SEALANTS

A. Vapor Barrier Coatings: Used in conjunction with reinforcing mesh to coat insulation on below ambient services temperatures. Permeance shall be no greater than 0.08 perms at 37 mils dry as tested by ASTM D5590 meeting zero growth rate for mold. Foster 30-80 or approved equal, or approved equal.

B. Lagging Adhesives: Used in conjunction with canvas or glass lagging cloth to protect equipment/piping indoors. Foster 30-36 AF meeting ASTM D 5590 with zero mold growth rating, or approved equal.

C. Weather Barrier Mastic: Used outdoors to protect above ambient insulation from weather. Foster 46-50 Weatherite; Childers CP-10 Vi Cryl, or approved equal.

D. Fiberglass Adhesive: Used bond low density fibrous insulation to metal surfaces. Shall meet ASTM C916 Type II. Foster 85-60; Childers CP-127, or approved equal.

E. Elastomeric Insulation Adhesive: Used to bond elastomeric insulation. Foster 85-75; Childers CP-82, or approved equal.

F. Elastomeric Insulation Coating: Water based coating used to protect outside of elastomeric insulation. Foster 30-65, Armacell WB Coating or approved equal.

G. Insulation Joint Sealant: Vapor sealant for below ambient piping with polyisocyanurate and cellular glass insulation. Foster 95-50; Childers CP-76, or approved equal.

H. Metal Jacketing Sealant: Used as a sealant on metal jacketing seams to prevent water entry. Foster 95-44; Childers CP-76, or approved equal.

3.0 PART 3 – EXECUTION

3.1 GENERAL REQUIREMENTS

A. Provide Thermal Insulation:

1. Insulation is required on ductwork, piping and equipment in compliance with these specifications and referenced codes and standards.

2. Continuous through openings, sleeves and hangers.

3. Install only on clean, dry surfaces and after ductwork has been tested.

4. On cold surfaces provide continuous unbroken vapor seal. Exceptions - Do not cover inspection stampings, nameplate data, openings, petcocks, hand-holes, manholes, access doors, plugged outlets, air vents, plugged openings or petcocks. Provide continuity of insulation system and vapor barrier though partitions, floors, casings, plenums, etc.

5. Piping insulation exposed to the weather shall be protected from damage, including that due to sunlight, moister, equipment maintenance and wind, and shall be provided with a jacketing material as specified in these specifications.

3.2 PIPE INSULATION

A. Insulate piping systems including fittings, valves, flanges, unions, strainers, and other attachments installed in piping system, whether exposed or concealed, with the following exceptions:

1. Factory-installed piping within the HVAC equipment tested and rated in accordance with the 2020 ECCCNYS

2. Factory installed piping within room fan coil Units and unit ventilators tested and rated according to AHRI 440 and AHRI 840, respectively.

3. Piping that conveys fluids that have a design operating temperature range between 60 and 105 degrees.

4. Piping that conveys fluids that have not been heated or cooled through use of fossil fuels or electric power, the surface temperature of which does not risk condensation or occupant / service hazard (between 60°F and 105°F).

5. Strainers, control valves and balance valves associated with piping 1 inch or less in diameter and conveying fluids over 60 degrees.

B. Piping in exterior walls, spaces, overhangs, attics, or where subject to freezing, double the thickness of the insulation. Piping in wall chases adjacent to an exterior wall shall be packed with type glass fiber batting type insulation.

C. Hanger Shields: Refer to Section "Piping Systems and Accessories."

1. Pre-insulated type: Butt insulation to hanger shields and apply a wet coat of vapor barrier cement to the joints and seal with 3 in. wide vapor barrier tape.

D. Joints in sections of pipe insulation shall be made as follows:

1. Standard: Longitudinal laps and butt joint shall be fully sealed. Factory applied pressure sensitive adhesive lap seal is acceptable.

2. Vapor barrier: For cold services, all service jacket (ASJ) longitudinal laps and 4 in. vapor barrier strip at butt joints shall be sealed with vapor barrier coating. Seal ends of pipe insulation at valves, flanges, and fittings with vapor barrier coating and reinforcing mesh.

E. Fittings, Valves and Flanges:

1. Hot services: Pre-molded fitting insulation of the same material and insulation value as the adjacent pipe insulation.

2. Hot water shall be coated with weather barrier mastic and reinforcing mesh.

3. Provide PVC fitting covers on all fittings.

F. Flexible Elastomeric Foam Pipe Insulation:

1. Split longitudinal joint and seal with contact adhesive. Carefully mate and seal with adhesive all contact surfaces to maintain the integrity of the vapor barrier of the system.

2. Fittings made from miter-cut pieces properly sealed with adhesive, or ells may be continuous. Use templates provided by the manufacturer and assemble the cut section in accordance with the manufacturer’s printed instructions.

3. Where exposed outdoors, apply water-based UV resistant coating and/or reinforcing membrane as recommended by manufacturer. Follow manufacturer’s installation instructions.

3.3 JACKETING ON PIPING

A. Secure jacketing to insulated piping with preformed aluminum band straps or stainless-steel band straps.

B. Jacket exposed insulated fittings, valves and flanges with mitered sections of aluminum or stainless-steel jacketing or factory fabricated, preformed, sectional aluminum or stainless-steel fitting covers shall be fully sealed water tight

C. Provide PVC, aluminum jacket and fitting covers on exposed insulated piping installed in finished rooms including Mechanical Equipment Rooms, Penthouses, and Machine Rooms within eight feet of the finished floor.

1. Where exposed in occupied spaces, all exposed piping shall be provided with PVC jacketing.

D. Lap all joints a minimum of 2 inches.

E. Secure jacketing in place with a continuous longitudinal friction type joint to provide a positive weatherproof seal. Circumferential joints shall be weatherproof sealed with 2 inch x 0.016 inch thick aluminum straps lined with metal jacketing sealant.

F. Install jacketing to avoid trapping condensation and precipitation.

3.4 DUCTWORK INSULATION

A. External thermal insulation for duct. Not required where ducts have internal acoustical insulation, are located inside the conditioned space and lining meets the insulation value of these specifications and the 2020 ECCCNYS. Make special provisions at dampers, damper motors, thermometers, instruments, and access doors. Apply as Follows:

1. Rigid board type: Impale board over mechanical fasteners, welded pins or adhered clips, 12 in. to 18 in. centers; minimum of two rows per side. Secure insulation with washers on clips. Seal breaks and joints in vapor barrier with 4 in. wide matching tape or 4 in. reinforcing mesh applied with Foster 30-65 vapor barrier coating. Apply tape over corner beading where exposed. Flexible blanket type: Joints and seams made with 2 in. lap of vapor barrier. Round ducts: Apply Foster 85-20 adhesive to ducts in 6 in. brush widths at 1 ft. intervals and at each facing edge. Square ducts: Over 18” duct face width, fasten by impaling insulation on adhered or welded clips. Secure insulation with washers on clips. Seal joints and breaks with 4 in. wide matching tape or 4 in. reinforcing mesh applied with Foster 30-65 vapor barrier coating. Cooling ducts shall be covered with a vapor retarder having a maximum permeance of 0.05perm or an aluminum foil jacket with a minimum thickness of 2 mils. All joints and seams shall be sealed to maintain the continuity of the vapor retarder.

2. Flexible blanket type: Joints and seams made with 2 in. lap of vapor barrier. Round ducts: Apply Foster 85-20 adhesive to ducts in 6 in. brush widths at 1 ft. intervals and at each facing edge. Square ducts: Over 18" duct face width, fasten by impaling insulation on adhered or welded clips. Secure insulation with washers on clips. Seal joints and breaks with 4 in. wide matching tape or 4 in. reinforcing mesh applied with Foster 30-65 vapor barrier coating.

3. Insulate the tube bends and all exposed surfaces of duct coils operating in excess of 10 degrees differential from ambient conditions.

4. Ductwork installed outdoors, exposed to weather.

   a. All duct insulation on ductwork installed outdoors shall be adhered 100 percent using Approved Contact Adhesive.

   b. Apply self-adhesive, laminated rubberized jacket per manufacturer's requirements. Apply to each side, starting with the bottom surface, then the sides, and finally the top. Provide minimum 3" overlap of material at each joint.

   c. Application:

      1) Flat ducts in a horizontal plane must be sloped to shed water. There must be no areas of ponding water.

      2) Install system over only clean, dry insulation base. Any insulation which becomes damp or damaged shall be removed and replaced prior to installation.

B. Service and access openings shall not be concealed by duct coverings unless the exact location of the opening is properly identified.

C. Continuous vapor barriers shall be provided on all ductwork subject to condensation. No gaps or methods for air to permeate the insulation materials below the vapor barrier shall be permitted.

3.5 EQUIPMENT INSULATION

A. Equipment insulation surfaces shall be a hard, smooth, uniform finish. Install Work ready for painting.

3.6 RECOVERING

A. Field apply glass cloth and applied over standard insulation jacket with lagging adhesive. Properly cut at fittings to avoid wrinkles and coat with lagging adhesive. Leave ready for painting.

3.7 EXISTING INSULATION

A. Patch existing insulation damaged during the course of the work.

B. Report any deficiencies in existing insulation systems to the Owner's Representative for further action.

3.8 EXISTING WORK

A. Insulate existing piping, ductwork and equipment where called for.

EXHIBIT "I" - PIPE INSULATION MATERIALS

SERVICE	INSULATION MATERIAL	THICKNESS	REMARKS
Hot water (200°F and lower)	Glass fiber	1-1/2 in. and Larger: 2 in. 1-1/4 in. and Smaller: 1-1/2 in.	
Chilled water	Glass fiber	1-1/2 in. and Larger: 1 in. 1-1/4 in. and Smaller: 1/2 in.	
Refrigeration Piping (Suction and liquid lines)	Elastomeric Foam	1 in. and Larger: 1 in. 3/4 in. and Smaller: 1/2 in.	
Outdoor Refrigeration Piping (Suction and liquid lines)	Elastomeric Foam	1 in. and Larger: 1 in. 3/4 in. and Smaller: 1/2 in.	Insulation shall be provided with a UV resistant coating, Aluminum Jacket
Domestic cold water	Glass fiber,	4 in. and Larger: 1 in. 3 in. and Smaller: 1/2 in.	
Outdoor Piping and piping within rooftop unit pipe cabinets	Same as called for above	Insulate pipe with double the thickness called for above	Cover with Self-Adhesive, Laminated Rubberized Jacket Aluminum Jacket
Piping in exterior walls, spaces, overhangs, attics, exterior, or where subject to freezing.		Insulate pipe with double the thickness called for above	

EXHIBIT "II" - DUCT INSULATION MATERIALS

SERVICE	INSULATION MATERIAL	THICKNESS	REMARKS
HVAC Supply Note – use duct liner only where specified or called for on drawings to R values to right. Where 1" is called for as acoustic measure, provide external insulation to balance of specified R value.	Exposed: Rigid fiberglass Concealed: Flexible fiberglass	1-1/2 in. 2 in.	Min. installed R value of 6 Min. installed R value of 6
Supply ducts, exposed within the conditioned space served where space and supply air are within 15 degrees of ambient.		NOT INSULATED	Does not include the associated supply ductwork within the Mechanical Room or supply duct to the conditioned space.
Interior ductwork indicated to be lined		NOT INSULATED	
Return-air ducts within heated building envelope		NOT INSULATED	
Air conditioning supply (insulated double wall)		1-1/2 in.	Total insulation value provided to meet R value of 8 where ductwork air stream is more than 15 degrees from ambient.
Outside air ducts and plenums, connections and mixing boxes	Rigid fiberglass	2 in.	Min. installed R value of 8 Provide neat fit at intake plenum
Exhaust, relief or vent ducts and plenums	Exposed: Rigid fiberglass Concealed: Flexible fiberglass	1-1/2 in. 2 in.	Min. installed R value of 8 Insulate 15 ft. from exterior opening and plenums
Outdoor Ductwork	Polyisocyanurate board	2-1/2 in. layers 3 in. layers	Supply, return duct and energy recovery exhaust ducts min, installed R value of 12. Cover with Self-Adhesive, Laminated Rubberized Jacket
Duct mounted coils	Rigid fiberglass	2 in.	Min. installed R value of 6 Exterior surface shall be paintable.

EXHIBIT "III" - EQUIPMENT INSULATION MATERIALS

SERVICE	INSULATION MATERIAL	THICKNESS	REMARKS
Air removal assemblies, air and dirt removal assemblies, side stream filter system and filter assemblies		SAME AS WATER PIPING	
Cooling system expansion tanks, chilled water buffer tanks and chemical feed tanks		SAME AS WATER PIPING	
Chilled water pumps and cold heat exchangers	Flexible sheets of Elastomeric foam	1 in.	Arrange for easy removal. Coat with white finish.

END OF SECTION 230700

SECTION 230923 – TEMPERATURE CONTROL SYSTEMS

1.0 PART 1 - GENERAL

1.1 FUNCTIONAL INTENT

A. Accessibility: As much as practical, design the system to keep the BACS equipment out of, and above user areas. The maintenance staff must have quick and ready access with sufficient room for operation and maintenance.

B. Reliability: Controls are integral to maintaining reliable conditions throughout the building and as such need to be designed and installed with an appropriate degree of robustness and reliability.

C. Digital Terminal Unit Control - This intent of this standard is to require digital electronic control down to the terminal level. Terminal level controls will typically be cost-effective controllers designed for the specific application. Stand-alone local controls may only be used when specifically approved by the Engineer.

D. Expandability - When configuring the BACS equipment, provision must be made for expansion that may be required in the future. Hardware and software required to implement expansion must be provided via system sizing, configuration, and appropriate license agreements

E. When a portion of an existing building is to be renovated, the new control system shall match or integrate seamlessly with the existing control system.

F. Unless stated to the contrary, all hardware points (AI, AO, BI and BO) shall be hardwired to controllers. Data points / BACNet Objects are only to be accessed through equipment integration where specifically called for.

1.2 RELATED SECTIONS

A. This Contractor shall reference the entirety of Divisions 22, 23 and 26 as they apply to this work, with specific attention to the following sections:

1. Section 230593 – Testing and Balancing

2. Section 019113 – Commissioning Requirements

3. Section 230514 – Electric Wiring

4. Section 262923 – Adjustable Speed Drives

1.3 DEFINITIONS

Binary Input (BI)	An on/off indication that has a maximum cycle rate of 1 Hz. This is typically sensing a contact closure
Binary Output (BO)	A contact closure on the controller that will cause inaction in the system

Binary Value (BV)	A network-visible binary point whose value is determined by a controller computation
Analog Input (AI)	A continuously varying voltage or amperage signal that is varied by a sensor in relation to a sensed variable. This signal is processed in the controller after an analog-to-digital converter on the controller that converts the analog signal to a digital value
Analog Output (AO)	A continuously varying voltage or amperage signal that is generated from the controller after digital-to-analog conversion. The voltage or amperage signal will be used, for instance, to drive a modulating actuator or reset a hardwired set point on a packaged device. 6. Analog Value (AV): A network-visible analog point whose value is determined by a controller computation
Analog Variable / Value (AV)	A network-visible analog point such as a setpoint or calculation result whose value is determined by a controller computation or user input
Building Management System (BMS)	Integrated DDC Temperature control system used both for system operation and troubleshooting meeting the requirements of this specification.

1.4 WORK INCLUDED

A. Provide labor, materials, equipment, services and warranty for a complete installation, startup and commissioning of motor control wiring and temperature control wiring as required in Contract Documents.

B. Provide wiring and conduit required to connect devices furnished as a part of, or integral to the automatic temperature control system, and for motor control and interlocks regardless of the source of supply.

1. Control wiring includes, as required, 120 volt and lower voltage wiring for control signals directing equipment operation. Control circuits shall be 24VAC in general, and no more than120 VAC where required.

2. Provide wiring in accordance with the requirements specified in Division 26, "Electrical", Section 230514 and the National Electrical Code.

3. Provide all devices required for proper system operation including electrical switches, transformers, disconnect switches, relays, device controllers and control modules, hubs, routers, temporary servers, actuators, transducers, sensors, safety devices, power supplies, mode selecting switches, enclosures, and circuit breakers.

4. Provide complete wiring and terminations. Provide all assembly, programming and test of all items as necessary to create a coherent system, encompassing all combined intents of design, drawings, specifications, addenda, and professional quality of work.

5. Assembly of all damper linkages and shafts, including extension through duct walls where applicable and mounting of actuators shall be by the Temperature Controls Contractor.

6. Mounting of all actuators and sensing devices shall be by the Temperature Controls Contractor.

C. The temperature controls contractor shall be responsible for extending 120vac power from designated power panels / circuit breakers to all temperature control panels.

D. Contractor shall provide calibration testing and required adjustment to CO2 space and ductwork sensors one year after system is commissioned. Refer to paragraph 2.2 of this section, Table 1 for CO2 sensor accuracy and "Common Elements" of the contract documents. If sensor is not within tolerance, device shall be replaced at contractors' expense.

E. Provide support requirements for Commissioning as described in Section 019113. The DDC temperature control system is a primary tool for HVAC Commissioning.

F. Coordinate all work with factory provided equipment controllers.

G. Coordination: Work with the Engineer, Commissioning Agent, air-balancing contractor, ventilation contractor, piping contractor and electrical contractor to provide proper and obstruction free component location, and system commissioning.

1.5 WORK NOT INCLUDED

A. Power wiring for motors, motor starters, adjustable speed drives, as well as the motors, motor starters, and adjustable speed drives (except in the case of equipment specified to have packaged controls/starters) are included in Division 26, "Electrical," unless otherwise called for.

B. Electrical wiring, interlocks or components specifically called out in the electrical specifications or drawings shall be included in the Division 26 scope of work.

1.6 ACCEPTABLE MANUFACTURERS

A. Maine-Endwell Central School District's existing Building Management System is Automated Logic, provided by Air Temp Heating & Air Conditioning, Inc. This project is designed around an extension of this system.

B. All control systems provided shall seamlessly integrate with the existing system without the use of integrator panels, routers, or any other hardware or software. The control system manufacturer shall guarantee that all new controls operate with the existing Automated Logic Controls System.

C. All temperature control equipment for this project shall be purchased by the school district (Maine-Endwell CSD) via state contract with the district's temperature controls contractor, Air Temp Heating & Air Conditioning, Inc. and turned over to the Mechanical (HVAC) contractor for installation. The Mechanical contractor shall be responsible to provide the services to develop the direct digital temperature controls such that the project has a complete and workable direct digital temperature controls system compliant with the requirements of Section 230923.

D. Basis of Design: Automated Logic

1.7 WORK INCIDENTAL TO TEMPERATURE CONTROL CONTRACTOR

A. The temperature control contractor shall furnish the following materials, for installation by the contractor responsible for HVAC piping and sheet metal (Sections 232000 and 233000) scope of work.

B. For piping work - Section 232000 Contractor shall install:

1. Control valves in piping.

2. Immersion sensing wells in piping systems.

3. Valved pressure taps (typically for pressure switches or sensors)

C. For sheet metal work - Section 233000 Contractor shall install:

1. Automatic Control Dampers:

a. Control dampers, at the direction of the Temperature Controls Contractor.

2. The Mechanical Contractor shall provide access doors or other means of access through ducts or ceilings and walls for service and adjustment of controllers, valves, and dampers.

D. Control system manufacturer or their authorized representative shall furnish written details, instructions and supervision for the above trades to ensure proper installation, size, and location of any equipment furnished for installation by others.

1.8 QUALITY ASSURANCE

A. Acceptable Products: All products shall be proven to be functional and suitable in accordance with this specification for a period of warranty commencing on the day of transfer of completed project to the Owner. Demonstration of such warranty may be required prior to the submittal approval.

B. Contractor Qualifications: The Temperature Controls Contractor shall be factory-authorized by the respective manufacturer to provide pertinent installation and service.

C. Any subcontractors in employ of the Temperature Controls Contractor on this project must receive prior approval to be permitted work on this project.

D. Field Representation: The Temperature Controls Contractor shall staff the project with a field representative that has been factory-trained in the installation, programming and commissioning of the equipment specified. This representative must be in the direct employ of the Temperature Controls Contractor.

E. Coordination of Work During Construction – this contractor shall:

1. Protect work installed by other trades

2. Coordinate its work with other trades

3. Repair any damage caused by his work

4. Promptly correct all work that Engineer finds as defective or failing to conform to Contract Documents

5. Bear all cost of correcting of work found defective as described above.

1.9 SHOP DRAWINGS AND SUBMITTALS

A. Product Data: Submit for approval the manufacturer's technical product data for each component furnished as part of the control system. Data shall include dimensions, capacities, performance characteristics, electrical requirements, and material finishes. Data shall also include installation and start-up requirements.

B. Shop Drawings: Submit for approval control drawings detailing the following:

1. Network Block Diagrams and System Riser Diagrams: These diagrams shall depict all DDC components that make up the network. They shall provide specific detail on network terminations, and panel power requirements, including breaker allocation. Each DDC panel within the diagram shall list the equipment that it is controlling.

2. Point-to-point Termination Detail: These drawings shall be created for each unique control application type. Drawings that are typical for similar application shall state the application and quantity of that they represent, and the specifics for each. All wiring and piping required to install and operate the system shall be represented in these details. For terminations that are unknown at the time of submittal, or introduced over the course of project, properly designate these as “Field determined terminations,” and include in the As-built Drawings after completion. All wiring and piping shall be number coded on the drawings. These tag numbers shall be used during the installation, and shall appear at both ends of all conductors, including within any junction boxes.

3. Provide individual details for each control type, as described in the Sequence of Operation.

4. Provide spreadsheets of schedules for dampers, valves, wiring, fans and other miscellaneous components if they are part of this control contract showing sizes, characteristics, model numbers and specific locations.

5. For prefabricated control panels, provide panel’s interior and exterior layout details. These details shall depict the equipment layout and shall detail the panel wiring and piping.

C. Product Data: The BACS vendor shall submit manufacturer’s technical product data for each control device, panel, controller, and accessory furnished indicating dimensions, capacities, performance and electrical characteristics, and material finishes. Also, include installation, start-up, calibration, and maintenance instructions as well as all cable and tubing requirements.

D. Database Information: The submittal package shall contain detailed information on the point naming convention that is to be used.

E. Provide documentation for all sequences of operation that cannot be performed by stand-alone controllers and require non-controller-resident programs, or programs requiring retransmission to be effective on the controller's output. Wherever possible, sequences of operation and associated inputs and outputs shall be contained on a single controller.

F. BACnet Protocol Implementation Conformance Statement (PICS) for each submitted type of controller and operator interface. All controllers and operator interface shall fully conform to ANSI/ASHRAE 135: Data Communication Protocol for Building Automation and Control Systems (BACNET).

1.10 OPERATION AND MAINTENANCE MANUALS FOR COMPLETE PROJECT

A. Upon completion of installation and prior to the training, provide manuals containing the following information:

1. Installation and Service Manuals for all products and components

2. Calibration and Troubleshooting Procedures for all installed equipment and components.

3. List of location of all enclosures, controllers, sensors, transformers and other components as specified above

4. As-built Control Drawings with all modifications, changes and wiring details that depict actual installation. These shall include all final controller and device names, locations for concealed components (pressure sensors, etc.),wire tags, etc.

5. Sequence of operation – Describing in detail the operation of every piece of equipment subject to control by the DDC system. Each section of the sequence should contain the following:

a. Overview – describes what the intent is, what components are involved and provides a concise description of the piece of equipment to be described.

b. Occupied Mode – Describes the operation of this system during occupied periods.

c. Unoccupied Mode – Describes the operation of this system during unoccupied periods.

d. Alarm Mode - Describes operation of the system in the event of alarm condition and steps to restore system to normal operation. List all anticipated alarm conditions.

e. Each Component's individual Sequence - Describes the detailed operation of each component and how it interacts with the entire system.

6. Listing of the entire DDC controllers with database, software and programs and program locations.

7. Provide spreadsheets of schedules for enclosures, control modules, dampers, valves, wiring, fans, well, tap and other miscellaneous components if they are part of this control contract showing sizes, characteristics, model numbers and specific locations.

B. Provide laminated control diagrams in each control panel for each piece of major controlled equipment or system.

C. Backup database information in electronic format (other than resident on computer hard drive) to be left on-site that will allow the Owner to fully download the entire DDC System software, including programming point database, configuration, graphic screens and all library of typically composed objects, and details supporting navigation, screens and graphics.

D. Within five working days from the time of the final system commissioning, one (1) hard copy and one (1) electronic copy in PDF format of Operation and Maintenance Manuals shall be turned directly to the Engineer.

E. A Programmers Manual shall be provided with graphic and text descriptions of all functions required for software modifications and developments. The use and installation of high-level programming language shall be included in this manual. The manual shall include ASCII text (or block diagram printouts for graphical programming language based systems) of all DDC programs with the spreadsheet inventorying the name and location of each program. Each file shall be accompanied by a “plain English” description of the program operation by subroutine to assure that future programmers can easily modify the existing database. The manual shall contain computerized printouts of all data file construction including all point information, physical terminal relationships, scales and offsets, alarm limits, messages, schedules, etc. The manual should also contain:

1. System overview

2. Networking concepts

3. Launching browsers from log in

4. Schedule manipulation

5. Software upload and download instruction, including field devices

6. Trend and alarm creation and maintenance

7. Report generation

8. Backup procedure for entire system and modular controllers

9. Sequence of Operation

F. Section for each Major Piece of equipment – Contains the cutsheets for the controllers, custom programs, and relevant information pertaining to that piece of equipment. (IE: schedules for AHUs showing Equipment Tag, Controller address, serial #, airflow, and pertinent engineering units like MBH, GPM, etc…).

G. Wiring Details – Contains 8-1/2" x 11" drawings of all the wiring details shown throughout the set of drawings.

H. Instrumentation Cut sheets – Contains the Manufacturer's original cut sheets for all the instrumentation used on the job. (IE: Well sensor, transformers, enclosures, pressure sensors, etc.).

I. AutoCAD Drawings – All drawings shall be provided in Auto CAD format (i.e. each file format should have the ".dwg" extension), made as set of both, a set 11"x17" black and white and a set of 24"x36" (1 color set and 3 black and white sets). Drawing Sets consists of the following:

1. System Description Drawing – Shows the overview of the job and what is being controlled.

2. Network Riser Drawings – Shows how the network is connected between all the devices on the job

3. Detail drawing(s) – Shows all the wiring and piping details for the entire job – all other drawings refer to these drawings.

4. Individual Control panel drawings & Schematics (1 or 2 drawings per piece of equipment) Shows the EXACT wiring and layout of each control panel. Also shows the schematic representation of the system that is being controlled. (IE: AHU, HW Plant, Fan Coil, Etc.)

5. Controls Floor plans (at least 1 for each floor) – Shows the approximate location of the control panels, thermostats, equipment, network wiring, thermostat wiring and any specific controls required for the job. All this information is overlaid on top of the mechanical floor plan showing the architectural layout (Wall and room #'s).

J. All above shall be copied to a CD (or another approved electronic format) and released to the Owner.

1.11 SYSTEM PRE-COMMISSIONING

A. In addition to responsibilities described within section 019113, and prior to formal project commissioning contractor shall complete the following Pre-Commissioning requirements to assure operational readiness of equipment prior to conducting commissioning.

B. Equipment Start-up: Upon completion of installation, all equipment being controlled shall be initially started and tested on site using a workstation configured identically to that to be presented for permanent use by the Owner, including graphical user interface. Upon completion of all system pre-commissioning (and 019113 commissioning) the entire contents of the workstation, including all changes and corrections performed during these phases, shall be re-loaded to the permanent operator workstation.

C. System Pre-Commissioning shall document the following:

1. Measure, calibrate and adjust all analog inputs. This is to be performed in a manner that verifies that sensors meet the accuracy requirements as specified for the device. All measurements shall be taken using an instrument certified for accuracy within a 12 month period.

    a. Where multiple sensors are “in line” within an air handling system – such as VAV leaving air temperature sensors vs an AHU leaving air temperature, or return / mixed / coil discharge sensors (with economizer correctly positioned) within an air handler, only one of the sensors need be directly measured, and the balance may be validated against the reference sensor.

    b. Where multiple sensors are “in line” within a piping system, the system may be manipulated such that only one sensor need be directly measured, and the balance may be validated against the reference sensor.

2. Stroke all analog outputs from 0% to 100%

    a. Visually verify that all linkage adjustments are set properly.

    b. Verify and record range of operation for ASD commands

    c. Verify and calibrate ASD feedback signals to correspond with command signal and actual operating speed in either RPM or HZ.

3. Valves and Dampers shall fully close and provide tight shut-off.

    a. Hydronic coils – verify that no temperature rise / drop occurs with the valve commanded fully closed

    b. Economizers – Verify return air temperature =mixed air temperature at 100% return air position, mixed air temperature = outdoor air temperature at 100% outdoor air position

4. Verify that all binary outputs are properly energizing the controlled device.

5. Verify that all binary inputs are properly calibrated to accurately reflect status of monitored equipment

6. Adjust setpoints so that equipment operates properly. Tune all PID control loops to avoid unnecessary cycling of control equipment, overheating, sub-cooling, tripping of freezestats or other limit switches and safeties. Create trends for review by the Engineer and Commissioning Agent.

7. Provide control and operational assistance to the balancing personnel during testing and balancing procedures.

D. Communication Network Start-up: Verify from a host computer that all configured controllers are engaged in proper communication passing all configured points to viewing stations. Verify communication speed and level of transactions until it is acceptable and meets the requirements of this specification.

E. Software Verification: All programs and software functions shall be verified to be in compliance with the contract documents for proper sequence of operation.

F. Pre-Commissioning Report: A report shall be provided to the Engineer detailing the dates, times and person(s) performing each phase of the specified system pre-commissioning. This report shall detail when and who performed the individual processes described in this section, and documents the results of all testing procedures. Coordinate phasing of work such that this can be completed PRIOR to formal system commissioning.

G. Project commissioning is considered complete only once the following are completed:

1. All points connected to the BMS shall operate in full compliance with this specification before project substantial completion is acknowledged.

2. The project formal commissioning as outlined under section 019113 is performed, including completion of all remedial work to correct Issues log items,

3. A physical walk-though of the project, conducted by the Engineer or Commissioning Agent and attended by the Temperature Controls Contractor and Owner or their authorized representative is concluded

4. The complete set of required closeout documentation is provided by the contractors. The Owner has no right to refuse or delay a reasonably scheduled walk through. The Owner and Engineer shall determine the level of detail required for the walk-through, and may take this to a component level inspection, at their discretion.

1.12 TRAINING

A. Provide BMS training for up to four (4) Owner selected personnel.

B. After Section 019113 Commissioning is complete as specified, the Temperature Controls Contractor shall provide an on-site session detailing the layout of the BMS. This shall include network wiring routes, control panel locations, transformer locations, etc.

C. The Temperature Controls Contractor shall then provide an on-site session to review the entire Operations and Maintenance manual(s) with the Owner. This session shall also include but not be limited to:

1. Fundamental operation of the system

2. Training on setpoint adjustment and scheduling modifications

3. Operation and sequencing of control loops for all mechanical equipment being controlled

D. Provide telephone support and answer system relevant questions throughout the warranty period.

1.13 WARRANTY

A. Warranty for the entire control system shall commence upon completion and acceptance by the Engineer of the system commissioning as specified. The warranty includes fine-tuning of all dynamic elements of control system to achieve reasonable, efficient end equipment protective mode of operation.

B. Provide a one-year warranty on all DDC controllers.

C. Provide a one-year warranty on all other components.

D. Disclose to Owner and accommodate longer warranty periods if provided by components manufactured at the time of purchasing.

E. The Contractor shall provide all OEM recommended preventative maintenance of the installed work as described in the operating and maintenance manuals during the warranty period. In addition, the Contractor shall provide two (2) semi-annual service visits (i.e., one visit during the peak cooling season and one visit during the peak heating season) to test and evaluate the performance of the installed work. The Contractor shall provide a written report of the test and evaluation results. The service visits shall include, but not be limited to:

1. Checking and, if necessary, correcting the calibration of the sensors, transducers, and transmitters for airflow, liquid flow, pressure, and temperature.

2. Checking and, if necessary, correcting the operation of the dampers and damper actuators.

3. Checking and, if necessary, correcting the operation (i.e., monitoring and command) of the system points, graphics, and display functions.

F. Software and Hardware Updates: At the end of the first six months after acceptance, and during the subsequent six-month period, the BACS contractor shall update the equipment and any controllers, servers, workstations and HMI web servers with the latest modification and improvements in software, firmware, and hardware that the manufacturer may have incorporated in the furnished equipment.

G. Contractor shall, during the ensuing four seasons (one year), conduct periodic inspections and fine-tune all dynamic elements of the system with all costs of testing to be included in this scope of work.

2.0 PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. General Requirements

1. A distributed logic control system, complete with Direct Digital Control (DDC) software shall be provided. This system is to control all mechanical equipment, as described on the project drawings and these specifications.

2. All BMS controllers, including (but not limited to) those for terminal units, air handlers, central mechanical equipment and systems shall be as manufactured by a single manufacturer, the hardware from which has been represented by this contractor for no less than a 10 year period.

3. All controllers for terminal units, air handlers, central mechanical equipment and the Microsoft Windows-based operator's terminal(s) shall communicate and share data.

4. All controllers shall be fully programmable.

5. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each DDC Controller shall operate independently by performing its own specified control, alarm management, operator I/O, and data collection. The failure of any single component or network connection shall not interrupt the execution of any control strategy, reporting, alarming and trending function, or any function at any operator interface device.

6. DDC Controllers shall be able to access any data from, or send control commands and alarm reports directly to, any other DDC Controller or combination of controllers on the network without dependence upon a central or intermediate processing device. DDC Controllers shall also be able to send alarm reports to multiple operator workstations without dependence upon a central or intermediate processing device.

7. All control points associated with a single piece of equipment (air handler, VAV air terminal, heat exchanger, pump control, etc.,) shall be wired to the local controller. Network sharing of data via the network, for example, remote monitoring of a temperature sensor to control a valve or other devices, shall not be permitted without advance permission from the Engineer.

8. The Temperature Controls Contractor shall assume complete responsibility for the entire controls system as a single source, providing installation, program debugging and service of all portions of logic control system. This shall include designated server, operator’s terminal, global controllers, routers, terminal unit controllers, sensors and all other sections of the system.

9. During construction, at least one operator's terminal shall be equipped to act as a system server / operator interface. This system server shall store copies of all installed software for all field components and shall be capable of automatic or manual reloading of such software into the field components as required. The system server shall also gather and archive system-operating data, such as trends, energy logs, and other historical operating data. Complete energy management firmware, including self-adjusting optimum start, demand limiting, global control strategies and logging routines for use with total control systems shall be supplied. All energy management firmware shall be resident in field hardware and shall not be dependent on the operator's terminal for operation. Operator's terminal software is to be used for access to field-based energy management control firmware only. All schedules shall be module resident and shall not be affected in case of interruption network transport between the module and the host station.

B. Basic System Features

1. Direct digital logic control of temperature, scheduling, optimum start, equipment alarm reporting and override devices for unoccupied mode of operation.

2. Operator's terminal software (Graphical User Interface or GUI) shall run under Microsoft Windows operating system. Software shall be multi-tasking, capable of executing and displaying multiple instances in individual windows while running concurrently with other Windows programs such as word processors or database programs. Operation of the terminal software shall be simple and intuitive.

3. Operator's terminal software shall contain graphical user interface software, allowing configuration of system-wide controllers.

4. Provide all communication media, connectors, repeaters, bridges, switches, and routers necessary for network communications and interface to the internet as required to allow for remote access to system operations.

5. The system shall meet peer-to-peer communication services such that the connection of any operator interface to any one controller shall allow the operator to interface with all other controllers. The software shall provide transparent viewing and editing of all data, control programs, schedules, trends, alarms from any one controller through connection to any other controller on the internet work, regardless of subnetwork routers.

6. Priority password security systems shall prevent unauthorized use. Each user shall have an individual password. The user shall only be given access to the system functions required for individual job performance.

7. Equipment monitoring and alarm functions, including information for diagnosing equipment problems shall be included with the system.

8. The complete system, including, but not limited to terminal unit controllers, higher level controllers and operator's terminals shall auto-restart, without operator intervention, on resumption of power after a power failure. Database stored in any controller's memory shall reside error free for a minimum of 30 days. Logic controllers for all air handlers and all unitary equipment shall utilize EEPROM or battery backup for all variable data storage.

9. System design shall be modular.

10. All software and/or firmware interface equipment for connection to remote monitoring station from field hardware or the operator's terminal shall be provided.

11. System shall be capable of equipment runtime totalization of fans, heaters, boilers, etc. And capable of alarm generation and alarm dial out.

12. All hardware shall be listed Underwriters Laboratory for Open Energy Management Equipment (PAZX) under the UL Standard for Safety 916 in both the US and Canada, with integral labels showing rating.

13. All hardware shall be in compliance with FCC Part 15, Subpart J, Class A.

2.2 SYSTEM PERFORMANCE

A. Performance Standards. System shall conform to the following minimum standards over network connections. Systems shall be tested using manufacturer's recommended hardware and software for operator workstation.

1. Graphic Display. A graphic with a minimum of 20 dynamic points shall display with current data within 10 sec.

2. Graphic Refresh. A graphic with 20 dynamic points shall update with current data within 8 sec.

3. Configuration and Tuning Screens. Screens used for configuring, calibrating, or tuning points, PID loops, and similar control logic shall automatically refresh within 6 sec.

4. Object Command. Devices shall react to command of a binary object within 2 sec. Devices shall begin reacting to command of an analog object within 2 sec.

5. Alarm Response Time. An object that goes into alarm shall be annunciated at the workstation within 15 sec.

6. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 1 sec. Select execution times consistent with the mechanical process under control.

7. Performance. Programmable controllers shall be able to completely execute DDC PID control loops at a frequency adjustable down to once per sec. Select execution times consistent with the mechanical process under control.

8. Multiple Alarm Annunciation. Each workstation on the network shall receive alarms within 5 sec of other workstations.

9. Control Stability and Accuracy. Control loops shall maintain measured variable at setpoint within tolerances listed in Table 1.

Table 1 - Control Stability and Accuracy

Controlled Variable	Control Accuracy	Range of Medium
Water Flow	±2% of full scale	
Dew Point (note 1)	±1.5ºF	
Water Temperature	±1.2 ºF	
Air Pressure (note 2)	±0.05 in. w.g.	1-6 in. w.g.
Air Pressure (note 2)	±0.03 in. w.g.	±0.25-1 in. w.g.
Air Pressure (note 2)	±0.005 in. w.g.	±0-0.25 in. w.g.
Airflow	±5% of full scale	
Space Temperature	±1.0ºF	
Duct Temperature	±1.2ºF	
Fluid Pressure (note 2)	±0.5 psi	
CO2 Sensors	50ppm	400-2000ppm

NOTE 1: Accuracy applies to 10% - 90% of scale

NOTE 2: For both absolute and differential pressure

GENERAL NOTE - Sensors to be selected such that measured media is near middle third of sensor range

2.3 TEMPERATURE SENSORS

A. General

1. Sensors shall have a limited lifetime warranty.

2. All devices shall use precision thermistors unless stated to the contrary in this section.

3. Provide NEMA 1 termination box unless otherwise specified

B. Sensor Specifications

1. Space Sensors:

a) Standard Space sensor shall be available in an off-white enclosure for mounting in a standard electrical box. Mount at 48” height.

b) Sensors in public areas shall be provided without local temperature indication, setpoint adjustment or setback override.

c) Sensors in private / staff only areas shall be provided with local temperature indication, setpoint adjustment and setback override functions.

d) Where potentially subject to damage (stairwells, gyms, corridors, toilet rooms) or as directed by the Owner or Engineer, provide bushed stainless steel blank wall plate type sensors.

e) Where space sensors are connected to dedicated terminal unit controllers, they shall be equipped with local communication interface for troubleshooting and balancing purposes. Provide all required wiring from the terminal controller to the space sensor to allow for interface to a local laptop interface device.

f) Wall Plate Sensors - Blank wall plate style sensors, Kele KTP3 Stainless Steel Flush Mounted Thermistor and RTD Sensors or approved equal. Provide only where specified or called out on project drawings

2. Duct Sensors:

a) Single point duct mounted sensors shall have a minimum 8" rigid probe and be used when the duct size is less than 24"or where duct stratification is not present, such as downstream of fans.

b) Averaging duct-mounted sensors shall have a minimum 8’ long averaging element and be used when the duct size is greater than 24". All averaging sensors shall use true averaging elements such as platinum (or equivalent) or balco. Averaging bridges [multi-point sensors] are specifically not permitted. Provide averaging sensors in all locations where specified or where temperature stratification can occur. Minimum element to be provided, 1 ft. per 2. sq ft of area. Securely support all elements to avoid movement in air stream or long term damage at stress / mounting locations. Supports shall provide radius bend support and insulation to avoid thermal bridging.

c) Averaging duct-mounted sensors shall have a minimum 8’ long averaging element and be used when the duct size is greater than 24". Where multi-point thermistor averaging sensors are to be used, sensing element spacing not to exceed 16”. Provide averaging sensors in all locations where specified or where temperature stratification can occur. Minimum element to be provided, 1 ft. per 2. sq ft of area. Securely support all elements to avoid movement in air stream or long term damage at stress / mounting locations. Supports shall provide radius bend support and insulation to avoid thermal bridging.

3. Well Sensors:

a) Liquid immersion sensors shall have a stainless-steel probe and a stainless steel or brass well. Length of the sensor well shall be selected based on the diameter of the pipe to provide accurate, reliable sensing of the liquid temperature.

4. Outside Sensors:

a) The sensing element shall mounted inside a ventilated, treated, sun shield to minimize the radiant energy and wind effects. Sensor location shall be selected to minimize effects from sunlight, building heat, exhaust systems, etc. Temperature Controls Contractor shall be responsible for selection of an appropriate location. Where sensor location is determined to be adversely affected by outdoor conditions, this contractor shall relocate the sensing devices to a more reliable position.

2.4 THERMOSTATS

A. Low-Voltage Space Thermostats. Low-voltage space thermostats shall be 24 V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed setpoint adjustment, 13°C-30°C (55°F-85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover.

B. Line-Voltage Space Thermostats. Line-voltage space thermostats shall be bimetal-actuated, open-contact type or bellows-actuated, enclosed, snap-switch type or equivalent solid-state type, with heat anticipator, UL listing for electrical rating, concealed setpoint adjustment, 13°C-30°C (55°F-85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover.

2.5 HUMIDITY SENSORS

A. Duct and room sensors shall have a sensing range of 20%-80%, minimum accuracy of +/-2% over this span.

B. Outdoor air humidity sensors shall have a sensing range of 20%-95% RH, minimum accuracy of 2% over this span, and shall be suitable for ambient conditions of 0°F-140°F.

C. Humidity sensors shall not drift more than 1% of full scale annually.

D. Temperature compensation of RH reading.

E. Two-year warranty from date of installation.

2.6 FLOW SWITCHES.

A. Flow-proving switches shall be paddle (water service only) or differential pressure type (air or water service). Switches shall be UL listed, SPDT snap-acting, and pilot duty rated (125 VA minimum).

B. Paddle switches shall have adjustable sensitivity and NEMA 1 enclosure unless otherwise specified.

C. Differential pressure switches shall have scale range and differential suitable for intended application and NEMA 1 enclosure unless otherwise specified.

2.7 RELAYS

A. Control Relays. Control relays shall be UL listed, and shall have dust cover and LED "energized" indicator. Contact rating, configuration, and coil voltage shall be suitable for application.

B. Time Delay Relays. Time delay relays shall be solid-state, UL listed, and shall have adjustable time delay. Delay shall be adjustable ±100% from setpoint shown. Contact rating, configuration, and coil voltage shall be suitable for application. Provide NEMA 1 enclosure for relays not installed in local control panel.

2.8 OVERRIDE TIMERS

A. Unless implemented in control software, override timers shall be spring-wound line voltage, UL Listed, with contact rating and configuration required by application. Provide 0-6 hour calibrated dial unless otherwise specified. Flush mount timer on local control panel face or where shown.

2.9 CURRENT TRANSMITTERS

A. AC current transmitters shall be self-powered, combination split-core current transformer type with built-in rectifier and 4-20 mA two-wire output. Full-scale unit ranges shall be 10 A, 20 A, 50 A, 100 A, 150 A, and 200 A, with internal zero and span adjustment. Unit accuracy shall be ±1% full-scale at 500-ohm maximum burden.

B. Transmitter shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized.

C. Unit shall be split-core type for clamp-on installation on existing wiring.

2.10 CURRENT TRANSFORMERS

A. AC current transformers shall be UL/CSA recognized and shall be completely encased (except for terminals) in approved plastic material.

B. Transformers shall be available in various current ratios and shall be selected for ±1% accuracy at 5 A full-scale output.

C. Use fixed-core transformers for new wiring installation and split-core transformers for existing wiring installation.

2.11 VOLTAGE TRANSMITTERS

A. AC voltage transmitters shall be self-powered single-loop (two-wire) type, 4-20 mA output with zero and span adjustment.

B. Adjustable full-scale unit ranges shall be 100-130 Vac, 200-250 Vac, 250-330 Vac, and 400-600 Vac. Unit accuracy shall be ±1% full-scale at 500-ohm maximum burden.

C. Transmitters shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized at 600 Vac rating.

2.12 VOLTAGE TRANSFORMERS

A. AC voltage transformers shall be UL/CSA recognized, 600 Vac rated, and shall have built-in fuse protection.

B. Transformers shall be suitable for ambient temperatures of 4°C-55°C (40°F-130°F) and shall provide ±0.5% accuracy at 24 Vac and 5 VA load.

C. Windings (except for terminals) shall be completely enclosed with metal or plastic.

2.13 POWER MONITORS

A. Power monitors shall be three-phase type and shall have three-phase disconnect and shorting switch assembly, UL listed voltage transformers, and UL listed split-core current transformers.

B. Power monitors shall provide selectable output: rate pulse for kWh reading or 4-20 mA for kW reading. Power monitors shall operate with 5 A current inputs and maximum error of ±2% at 1.0 power factor or ±2.5% at 0.5 power factor.

2.14 CURRENT TRANSDUCER / EQUIPMENT INTERFACE RELAY

A. Low voltage, single phase:

1. Combined status sensor, command relay, and hand-off-auto switch.

2. Sized for monitor and control of small motors.

3. Field selectable relay output.

4. High and low voltage isolation.

5. Industrial grade load switching relay.

6. Mountable on single or double gang boxes, flush on starter enclosures, or stand-alone.

7. Approved for installation in the following environmental conditions:

a) 0-95% RELATIVE HUMIDITY, NON-CONDENSING.

b) –15° TO 60° C

8. Design equipment: Veris Hawkeye H500.

9. Alternative components combining the total functionality of the specified device may be submitted for approval.

2.15 PRESSURE TRANSMITTERS

A. Pressure transmitters shall be of 2-wire, 4-20 mA / 0-10vdc output type with a capacitance element having an accuracy of +/- 1% over the entire range. Transmitter shall include protection against reverse polarity and supply voltage transients. Accuracy and zero span adjustment shall be provided with each transmitter to allow for recalibration as necessary.

1. Liquid Pressure

a) The operating range shall be -40.0 to 176.0 F.

b) Safe overpressure shall be a minimum of 150% of the rated pressure.

c) Sensor range to be selected so anticipated control setpoint resides in the middle third of the sensor span.

d) Use of two discrete pressure sensors and mathematical determination of system differential pressure is acceptable.

e) Differential pressure sensor shall use a five-valve manifold to allow proper service and removal of air from the sensing lines without damage. Locate such that the lines from the primary piping can be properly drained and vented. Provide isolation at the mains to allow service to the assembly.

f) Shall be contained in an aluminum NEMA-1 enclosure.

2. Air Pressure

a) The operating range shall be 0 to 150.0 F.

b) Safe overpressure of 10psi.

c) Sensor shall be equipped with reverse polarity protection.

d) Accurate to within 1% over full scale

e) Sensor shall have ability for field zero of reading and output.

f) Bi-directional ranges available by application

g) Shall be contained in a NEMA-1 enclosure.

h) Not to be provided when Space Pressure Monitor (SPM) / Room Pressure Monitor (RPM) is specified or called out on the drawings.

i) Sensor warranty shall be 3 years.

j) Design Make – Setra 264 or approved equal

2.16 DIFFERENTIAL PRESSURE SWITCHES

A. Differential pressure switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum) and shall have scale range and differential suitable for intended application and NEMA 1 enclosure unless otherwise specified.

2.17 PRESSURE-ELECTRIC (PE) SWITCHES.

A. PE switches shall be UL listed, pilot duty rated (125 VA minimum) or motor control rated, metal or neoprene diaphragm actuated, operating pressure rated for 0-175 kPa (0-25 psig), with calibrated scale minimum setpoint range of 14-125 kPa (2-18 psig).

B. Provide one- or two-stage switch action (SPDT, DPST, or DPDT) as required by application.

C. Switches shall be open type (panel-mounted). Exception: switches shall be enclosed type for remote installation. Enclosed type shall be NEMA 1 unless otherwise specified.

D. Each pneumatic signal line to PE switches shall have permanent indicating gauge.

2.18 FLOW TRANSMITTERS

A. Airflow – Velocity over 1000 fpm

1. Acceptable for use only in applications where duct velocity will be maintained over 1000fpm over entire operating range of equipment.

2. Air flow monitoring stations requiring the use of “air straighteners” are specifically prohibited.

3. Constructed of 16-gauge galvanized steel casing, extruded aluminum sensors and copper collectors. Measured velocity pressure converted to air flow shall have accuracy within + 2% of the full scale from 700 to 4000 fpm. Sized by manufacture, rectangular, round or oval for application. Provide with volume meter with actual flow display, mounted on adjacent wall. Interface with DDC controllers.

4. Acceptable Makes: Cambridge, Air Monitor, Paragon

B. Airflow – Acceptable for all applications

1. Duct mounted airflow measuring station shall consist of one or more airflow/temperature measuring devices based on size of duct and all required electronics. The complete system shall be factory tested prior to shipment. The airflow measuring station shall not require calibration over the life of the equipment.

2. Fan inlet measurement devices shall not be substituted for duct or plenum measurement devices indicated on the plans without prior approval by the Engineer.

3. Each sensing point shall measure both airflow and temperature using a pair of instrument grade, hermitically sealed, glass encapsulated thermistors, one self-heated and one ambient temperature. Airflow rate sensing device shall utilize thermal dispersion technology. Individual sensor notes shall be individually calibrated at 16 points to NIST calibration standards. Sensors will read and system will compensate for air temperature and impact on velocity or CFM. Provide copy of NIST calibration report for the reference standard to calibration the production tunnels used to calibrate individual sensor nodes. Devices claiming AMCA certification are not acceptable.

4. Provide air flow measuring station transmitter including any 24 VAC transformer to interface with the BAS. Each measurement location shall produce a single, separate linear analog output signal for airflow and temperature where indicated, both of which can be directly interfaced to the BMS.

5. The system shall have the ability to perform self-diagnostics and produce an alarm, which can identify the source of malfunction. In the event of a sensor failure, the system shall ignore failed sensor(s), average remaining sensors and shall continue to operate.

6. Sensor range shall be minimum and maximum system airflow rates with an accuracy of ±2%. Sensors and electronics shall operate over a temperature range of -20° F to 120° F, acceptable for use over a range of 5-95% RH, non-condensing. Size for 125% of anticipated range of air flow. The number of independent sensing points shall be per manufacturer's recommendations for the specified application as shown on drawings.

7. Remote transmitters to be mounted in a location protected from moisture. Provide weatherproof enclosure and mount away from direct sunlight when outdoor mounting is required.

8. The probe body shall be constructed of extruded anodized aluminum alloy.

9. Provide a Bluetooth and Android/IOS software that allows real time airflow and temperature monitoring.

10. Provide required length of cable to location of adjacent transmitter station to be mounted in an accessible, convenient location for operator use. Prior to start-up, a factory trained representative shall visit the site to inspect installation of air flow measuring devices and wiring. A written report shall be submitted to the engineer for the start-up services.

11. Acceptable Make: Ebtron, Air Monitor

C. Fan Array and Single Fan Measurement.

1. For use only where specifically called for or approved in advance by the Engineer

2. Each AMD shall be suitable for installation in fan inlets to determine the airflow rate and velocity weighted temperature of the airstream. Piezo rings are not acceptable.

3. Each sensing point shall measure both airflow and temperature using a pair of instrument grade, hermitically sealed, glass encapsulated thermistors, one self-heated and one ambient temperature. Airflow rate sensing device shall utilize thermal dispersion technology. Individual sensor notes shall be individually calibrated at 16 points to NIST calibration standards. Sensors will read and system will compensate for air temperature and impact on velocity or CFM. Provide copy of NIST calibration report for the reference standard to calibration the production tunnels used to calibrate individual sensor nodes. Devices claiming AMCA certification are not acceptable.

4. Provide face, forward mount adjustable brackets for each sensor node. Mount styles shall not affect the airflow or sound performance of plenum fans.

5. Provide air flow measuring station transmitter including any 24 VAC transformer to interface with the BAS. Each measurement location shall produce a single, separate linear analog output signal for airflow and temperature where indicated, both of which can be directly interfaced to the BMS.

6. Provide the following number of sensor nodes based on fan type. All sensors shall be connected to a single, remote transmitter. Fan array models shall calculate the airflow of each fan individually prior to outputting the total airflow rate and have a built-in alarm capable of removing a failed fan from the total airflow calculation.

   a) SWSI fans – Two

   b) DWDI Fans – Two per inlet

   c) Fan Arrays – One per inlet

D. Liquid Flow

1. Insertion Type - Onicon F3500 or approved equivalent only

2. Install in compliance with all manufacturers requirements.

3. Provide type as specified on the contract drawings.

E. Remote Readout Unit:

1. Provide only where specified or shown on the drawings.

2. Able to accept signals from meter, temperature transmitter and pressure transducer.

3. Shall provide local display of actual flow rate, totalized flow (counter), and percent of full flow.

4. Shall provide a 4-20 mA DC analog signal to read actual flow and totalized flow at DDC controller.

5. 115V or 230V AC operation (+ 15%).

6. Provide in NEMA 4 enclosure. Mount on adjacent wall.

2.19 VOC SENSORS

A. Provide where specified or shown on the drawings

B. Contains calibration algorithm for correlation to CO2 concentration levels

C. Available as combination VOC / Temperature / Humidity sensor – coordinate with zone requirements.

D. Provide digital reading of VOC level and optional temperature and humidity.

E. Eighteen-month warranty from installation date

2.20 CO2 SENSORS

A. Space

a. Provide only where specified or shown on the drawings.

b. Dual Channel optical system for reference calibration

c. Optional temperature sensing – coordinate with zone requirements

d. 90% response time inside of 45 seconds at 25°C.

e. Local LCD display of CO2 concentration

f. Temperature and altitude compensation

g. 0-10v or 4-20 ma output

h. Accurate to within 50ppm between 400 and 2000ppm

i. Drift not to exceed 20ppm / year.

j. Eighteen-month warranty from installation date

B. CO2 Sensors – Duct

1. Provide only where specified or shown on the drawings.

2. Dual Channel optical system for reference calibration

3. 90% response time inside of 45 seconds at 25°C.

4. Temperature and altitude compensation

5. 0-10v or 4-20 ma output

6. Accurate to within 50ppm between 400 and 2000ppm

7. Drift not to exceed 20ppm / year.

8. Eighteen-month warranty from installation date

2.21 ENCLOSURES

A. Enclosures shall be NEMA-1 rated steel, finished to control oxidation in a highly humid atmosphere.

B. Each enclosure shall have a hinged door with handle and keyed lock

C. Shall provide 40% of free space for future expansion of the system.

2.22 DAMPER MOTORS

A. Electronic:

1. Electronic actuators shall be driven directly by 0-10 VDC, supply power: 24 VAC or 30VDC, as acceptable to its controller, and provide adequate torque to meet the application.

2. Where actuators over 30vdc requirement are supplied, coordinate with furnishing contractor for all wiring requirements in compliance with NEC and these specifications.

3. Electronic actuators shall be direct-coupled type.

4. For all actuators, assure execution of the fail-safe position in case of the Freezestat trip or power loss.

5. Actuators to be sized for smooth operation over entire range and a minimum of 150% of required torque for connected components.

6. Design Make: Belimo, Neptronic.

2.23 CONTROL DAMPERS

A. Rectangular;

1. Blades are extruded aluminum profiles. Aluminum end caps are press fitted to blade ends in order to seal hollow interior and reduce air leakage rates.

2. Blade and frame seals are extruded silicone and are secured in an integral slot within the aluminum extrusions.

3. Bearings are composed of a Celcon inner bearing fixed to a 7/16" (11.11mm) aluminum hexagon blade pin, rotating within a polycarbonate outer bearing inserted in the frame, resulting in no metal-to-metal or metal-to-plastic contact.

4. Linkage hardware is installed in the frame side and constructed of aluminum and corrosion-resistant, zinc-plated steel, complete with cup-point trunnion screws for a slip-proof grip.

5. Dampers are designed for operation in temperatures ranging between -40°F (-40°C) and 212°F (100°C).

6. Dampers are available with either opposed blade action or parallel blade action.

7. Leakage class 1A at 1" w.g. Static pressure differential. Standard air leakage data is certified under the AMCA Certified Ratings Program.

8. Two position dampers - Pressure drop not to exceed 0.2"wc as installed. If frame is fully within the duct, the pressure drop calculations shall account for this installation method.

9. Modulating Control Dampers shall be sized by the temperature control manufacturer. Maximum velocity shall be 1500 fpm and maximum pressure drop shall be 0.15 in w.g, not to exceed 0.2"wc. Dampers shall be of adequate authority and sized and positioned to allow for smooth modulation of controlled air streams.

10. Damper pressure drops shall take into account the as-installed position and be certified for pressure drop per AMCA standard 500-d.

11. Dampers are available in two mounting types: i.e., "Installed in Duct" or "Flanged to Duct".

12. Provide thermally broken frame design where use of standard frame could cause condensation or operational issues.

13. Installation of dampers shall be in accordance with current manufacturer's installation instructions.

14. Dampers over 48 in. In length and height shall be made into multiple sections.

15. Automatic dampers are required at all exterior walls and roof openings. Dampers to open when respective fan starts. Dampers at exterior walls and roof openings shall be insulated blade, thermal break design.

16. Design make: Tamco 1500 series (standard), Tamco 9000 series (outdoor air intake and exhaust / relief locations)

B. Round

1. Temperature Rating: Withstand maximum of 250 degrees F.

2. Minimum diameter 4 inches. Maximum 48 inch.

3. Capacity: Damper shall withstand HVAC system operating conditions:

4. Closed Position: Maximum pressure of 10 inches w.g @ a 6 inch diameter.

5. Open Position: Maximum air velocity of 4,000 feet per minute.

6. Leakage: Provide with damper blade seals. Maximum 10 cfm at 4 inches w.g. for 48 inch diameter damper.

7. Pressure Drop: Maximum 0.1 inch w.g at 1,000 feet per minute

8. Frame: Under 6 inch diameter; 2 inch x 12 gauge steel tube. 6 thru 12 inch, 2 inch x 0.5 inch x 14 gauge steel channel. Above 12 inch thru 24 inch, 2 x 0.5 x 1/8 inch steel channel. Above 24 inch; 2 x 1 x 3/16 inch steel channel.

9. Blade Style: Single skin round blade.

10. Material: Diameter 18 inch or under; 12 gauge steel. Diameter over 18 inch; 10 gauge steel (3.5 mm). Stiffeners as required.

11. Bearings: Stainless steel pressed into frame.

12. Seals: Neoprene ring.

13. Axles: Diameter 24 inch or under; 0.5 inch diameter plated steel. Diameter over 24 inch); 0.75 inch plated steel.

14. Actuation: Refer to Damper Actuators paragraph. Provide actuator mounting plate and extended shaft where required to allow proper insulation of duct insulation and damper actuator. Direct mount of actuator anti-rotation pin to the ductwork is not permitted.

15. Design Make: Ruskin CDR25

C. Oval

1. Temperature Rating: Withstand maximum of 250 degrees F.

2. Minimum diameter 6 inches. Maximum without center mullion is 36 inch x 24 inch. Maximum with center mullion is 72 inch x 24 inch. Capacity: Damper shall withstand HVAC system operating conditions:

3. Closed Position: Maximum pressure of 10 inches w.g @ a 6 inch diameter.

4. Open Position: Maximum air velocity of 4,000 feet per minute.

5. Leakage: Provide with damper blade seals. Maximum 8.5 cfm (2.7 l/s) at 4 inches w.g. (1 kPa) for 36 inch wide damper

6. Pressure Drop: Maximum 0.1 inch w.g at 1,000 feet per minute

7. Frame: Under 6 inch diameter; 2 inch x 12 gauge steel tube. 6 thru 12 inch, 2 inch x 0.5 inch x 14 gauge steel channel. Above 12 inch thru 24 inch, 2 x 0.5 x 1/8 inch steel channel. Above 24 inch; 2 x 1 x 3/16 inch steel channel.

8. Blade Style: Single skin round oval blade.

9. Material: Diameter 18 inch width or under; 12 gauge steel. Diameter over 18 inch; 10 gauge steel (3.5 mm). Stiffeners as required.

10. Bearings: Stainless steel pressed into frame.

11. Seals: Polyethylene Foam.

12. Axles: Diameter 24 inch or under; 0.5 inch diameter plated steel. Diameter over 24 inch); 0.75 inch plated steel.

13. Actuation: Refer to Damper Actuators paragraph. Provide actuator mounting plate and extended shaft where required to allow proper insulation of duct insulation and damper actuator. Direct mount of actuator anti-rotation pin to the ductwork is not permitted.

14. Design Make: Ruskin CDO25

2.24 CONTROL VALVES

A. General:

1. Valves shall be applicable for the rated pressure and temperature service. Close off pressures must be determined in concert with the actuators and valves shall be provided to close off against extreme anticipated conditions. Valves shall be selected such that they are not, as a practice, “oversized.”

2. Modulating valves shall be carefully selected to control in a smooth and stable fashion across the range of anticipated conditions. “Split ranging” of heating and cooling valves controlled by the BMS is not acceptable. A separate output from the BMS shall be provided for all control valves. When the selection criteria indicated below are not met, flow characteristic analyses shall be submitted to demonstrate reasonable correlation between stroke and flow.

3. Modulating actuators shall be selected for smooth actuation over the entire operating range, use a 24vac power supply, and respond to an electronic input of: 4-20 mA or 0-10 VDC.

B. Provide factory fabricated control valves with operators as required by this specification. Provide selection as determined by manufacturer for installation requirements and pressure class, based on maximum pressure and temperature in piping system. Provide valve size in accordance with specified maximum pressure drop across control valve. Equipment control valves with heavy duty actuators, with proper shut off rating for each individual application.

C. Valves shall be selected to perform as specified taking into account inlet and outlet piping geometry correction factors. Temperature control contractor shall instruct mechanical contractor on correct installation technique and verify that installation matches manufacturer's requirements for proper performance.

D. Design Pressure Drop –

1. Water Service Valves - Unless specified to the contrary, valves shall be selected for a pressure drop approximately equal to that of the connected equipment, but no greater than 5 psi or less than 3 psi at design water flow.

E. Ball Valves:

1. Modulating water valves shall be ball valves with an equal percentage characteristic.

2. Type: Two or three-way as called for, V-port ball valve with characterizing disk, 1/4 turn.

3. Packing: EPDM O-rings, lubricated.

4. Ball & Stem: Stainless steel.

5. Seat: Fiberglass reinforced Teflon.

6. Actuator: Electric, one motor only; valves 4 inches and larger shall have single operator.

7. Flow Characteristic: Equal percentage.

F. Actuator: Electric, one motor only

1. Failure positions shall generally be as follows, contact owner for special circumstances requiring deviation from these requirements:

a) Unit cooling coils: normally closed spring return

b) Unit heating coils: normally open spring return

2. Input signal: 0-10 VDC, equipped with spring failure position return all heating applications. "Floating point" actuation allowed only where specifically noted elsewhere in the contract documents.

3. The Back-to-back electronic actuations, i.e., where two identical actuators are engaged in operating the rising or rotation of valve stem are not permitted.

4. Valve Closeoff:

a) Water – 120% of total system (pump) head.

b) Steam – 200% of system operating (inlet) pressure.

c) Valves to be used on this project shall be suitable for complete closeoff to the levels stated under modulating duty. In the event that manufacturer's data provides a separate maximum differential pressure under modulating duty, both criteria shall exceed the above requirements.

2.25 SAFETY/STATUS DEVICES

A. Low Limit Detector ("freezestat"): Electric type, with manual reset and auxiliary contacts to the DDC, set for 37°F for "freeze" protection and 55°F for fan discharge application. Provide a 20' long element for every 25 sq. Ft. Of coil face area or fraction thereof. Low-Limit Thermostats. Low-limit airstream thermostats shall be UL listed, vapor pressure type. Element shall sense temperature in each 30 cm (1 ft) section and shall respond to lowest sensed temperature. Low-limit thermostat shall be manual reset only.

B. High Limit Detector ("firestat"): Electric type, with manual reset and auxiliary contacts to the DDC, UL Listed for fire, set for 180°F.

C. Pump status through adjustable range current sensing element on pump motor. Calibrate to actual conditions.

D. Fan status through adjustable range current sensing element on the fan motor. Calibrate to actual conditions.

2.26 COMMUNICATIONS

A. Install new wiring and network devices as required to provide a complete and workable control network.

B. Each controller shall have a communication port for temporary connection to a laptop computer or other operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations.

C. Internet operator interface and value passing shall be transparent to network architecture.

1. An operator interface connected to a controller shall allow the operator to interface with each internetwork controller as if directly connected. Controller information such as data, status, and control algorithms shall be viewable and editable from each internetwork controller.

2. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. Program and test all cross-controller links required to execute control strategies specified. An authorized operator shall be able to edit cross-controller links by typing a standard object address or by using a point-and-click interface.

D. System shall automatically synchronize system clocks daily from an operator-designated controller via the network. If applicable, system shall automatically adjust for daylight saving and standard time.

E. System shall be expandable to at least twice the required input and output objects with additional controllers, associated devices, and wiring.

2.27 OPERATOR INTERFACE

A. All operator workstation functions shall be provided / updated on the existing operator workstation(s) to reflect the new equipment and systems installed under this project.

B. Communication. Web server or workstation and controllers shall communicate using BACnet protocol. Web server or workstation and control network backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in ANSI/ASHRAE 135-2016, BACnet.

C. Operator Functions. Operator interface shall allow each authorized operator to execute the following functions as a minimum:

1. Log In and Log Out. System shall require user name and password to log in to operator interface.

2. Point-and-click Navigation. Operator interface shall be graphically based and shall allow operators to access graphics for equipment and geographic areas using point-and-click navigation.

3. View and Adjust Equipment Properties. Operators shall be able to view controlled equipment status and to adjust operating parameters such as setpoints, pid gains, on and off controls, and sensor calibration.

4. View and Adjust Operating Schedules. Operators shall be able to view scheduled operating hours of each schedulable piece of equipment on a weekly or monthly calendar-based graphical schedule display, to select and adjust each schedule and time period, and to simultaneously schedule related equipment. System shall clearly show exception schedules and holidays on the schedule display.

5. View and Respond to Alarms. Operators shall be able to view a list of currently active system alarms, to acknowledge each alarm, and to clear (delete) unneeded alarms.

6. View and Configure Trends. Operators shall be able to view a trend graph of each trended point and to edit graph configuration to display a specific time period or data range. Operator shall be able to create custom trend graphs to display on the same page data from multiple trended points.

7. View and Configure Reports. Operators shall be able to run preconfigured reports, to view report results, and to customize report configuration to show data of interest.

8. Manage Control System Hardware. Operators shall be able to view controller status, to restart (reboot) each controller, and to download new control software to each controller.

9. Manage Operator Access. Typically, only a few operators are authorized to manage operator access. Authorized operators shall be able to view a list of operators with system access and of functions they can perform while logged in. Operators shall be able to add operators, to delete operators, and to edit operator function authorization. Operator shall be able to authorize each operator function separately.

D. System Software

1. Operating System. Workstation server shall operate on Microsoft Windows 10.

2. System Graphics. Operator interface shall be graphically based and shall include at least one graphic per piece of equipment or occupied zone, graphics for each chilled water and hot water system, and graphics that summarize conditions on each floor of each building included in this contract. Indicate thermal comfort on floor plan summary graphics using dynamic colors to represent zone temperature relative to zone setpoint.

a) Functionality. Graphics shall allow operator to monitor system status, to view a summary of the most important data for each controlled zone or piece of equipment, to use point-and-click navigation between zones or equipment, and to edit setpoints and other specified parameters.

b) Animation. Graphics shall be able to animate by displaying different image files for changed object status.

c) Alarm indication. Indicate areas or equipment in an alarm condition using color or other visual indicator.

d) Format. Graphics shall be saved in an industry-standard format such as BMP, JPEG, PNG, or GIF. Web-based system graphics shall be viewable on browsers compatible with World Wide Web Consortium browser standards. Web graphic format shall require no plug-in (such as HTML and JavaScript) or shall only require widely available no-cost plug-ins (such as Active-X and Macromedia Flash).

e) Provide a link from each piece of graphically represented equipment to the associated wiring diagram and sequence of operation.

E. System tools. System shall provide the following functionality to authorized operators as an integral part of the operator interface or as stand-alone software programs. If furnished as part of the interface, the tool shall be available from each workstation or web browser interface. If furnished as a stand-alone program, software shall be installable on standard IBM-compatible PCs with no limit on the number of copies that can be installed under the system license.

1. Automatic System Database Configuration. Each workstation or web server shall store on its hard disk a copy of the current system database, including controller firmware and software. Stored database shall be automatically updated with each system configuration or controller firmware or software change.

2. Controller Memory Download. Operators shall be able to download memory from the system database to each controller.

3. System Configuration. Operators shall be able to configure the system.

4. Online Help. Context-sensitive online help for each tool shall assist operators in operating and editing the system.

5. Security. System shall require a user name and password to view, edit, add, or delete data.

    a) Operator Access. Each user name and password combination shall define accessible viewing, editing, adding, and deleting functions in each system application, editor, and object.

    b) Automatic Log Out. Automatically log out each operator if no keyboard or mouse activity is detected. Operators shall be able to adjust automatic log out delay.

    c) Encrypted Security Data. Store system security data including operator passwords in an encrypted format. System shall not display operator passwords.

6. System Diagnostics. System shall automatically monitor controller and I/O point operation. System shall annunciate controller failure and I/O point locking (manual overriding to a fixed value).

7. Alarm Processing. System input and status objects shall be configurable to alarm on departing from and on returning to normal state. Operator shall be able to enable or disable each alarm and to configure alarm limits, alarm limit differentials, alarm states, and alarm reactions for each system object.

8. Alarm Messages. Alarm messages shall use an English language descriptor without acronyms or mnemonics to describe alarm source, location, and nature.

9. Alarm Reactions. Operator shall be able to configure (by object) actions workstation or web server shall initiate on receipt of each alarm. As a minimum, workstation or web server shall be able to log, print, start programs, display messages, send e-mail, send page, and audibly annunciate.

10. Alarm Maintenance. Operators shall be able to view system alarms and changes of state chronologically, to acknowledge and delete alarms, and to archive closed alarms to the workstation or web server hard disk from each workstation or web browser interface.

11. Trend Configuration. Operator shall be able to configure trend sample or change of value interval, start time, and stop time for each system data object and shall be able to retrieve data for use in spreadsheets and standard database programs. Controller shall sample and store trend data and shall be able to archive data to the hard disk.

12. Object and Property Status and Control. Operator shall be able to view, and to edit if applicable, the status of each system object and property by menu, on graphics, or through custom programs.

13. Reports and Logs. Operator shall be able to select, to modify, to create, and to print reports and logs. Operator shall be able to store report data in a format accessible by standard spreadsheet and word processing programs.

14. Standard Reports. Furnish the following standard system reports:

    a) Objects. System objects and current values filtered by object type, by status (in alarm, locked, normal), by equipment, by geographic location, or by combination of filter criteria.

    b) Alarm Summary. Current alarms and closed alarms. System shall retain closed alarms for an adjustable period.

    c) Logs. System shall log the following to a database or text file and shall retain data for an adjustable period:

        (1) Alarm History.

        (2) Trend Data. Operator shall be able to select trends to be logged.

        (3) Operator Activity. At a minimum, system shall log operator log in and log out, control parameter changes, schedule changes, and alarm acknowledgment and deletion. System shall date and time stamp logged activity.

15. Graphics Generation. Graphically based tools and documentation shall allow Operator to edit system graphics, to create graphics, and to integrate graphics into the system. Operator shall be able to add analog and binary values, dynamic text, static text, and animation files to a background graphic using a mouse.

16. Graphics Library. Complete library of standard HVAC equipment graphics shall include equipment such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. Library shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. Library graphic file format shall be compatible with graphics generation tools.

17. Custom Application Programming. Operator shall be able to create, edit, debug, and download custom programs. System shall be fully operable while custom programs are edited, compiled, and downloaded. Programming language (or block language equivalent) shall have the following features:

    a) Language. Language shall be graphically based and shall use function blocks arranged in a logic diagram that clearly shows control logic flow. Function blocks shall directly provide functions listed below, and operators shall be able to create custom or compound function blocks.

b) Debugging and Simulation. Operator shall be able to step through the program observing intermediate values and results. Operator shall be able to adjust input variables to simulate actual operating conditions. Operator shall be able to adjust each step's time increment to observe operation of delays, integrators, and other time-sensitive control logic. Debugger shall provide error messages for syntax and for execution errors.

c) Conditional Statements. Operator shall be able to program conditional logic using compound Boolean (AND, OR, and NOT) and relational (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.

d) Mathematical Functions. Language shall support floating-point addition, subtraction, multiplication, division, and square root operations, as well as absolute value calculation and programmatic selection of minimum and maximum values from a list of values.

e) Variables: Operator shall be able to use variable values in program conditional statements and mathematical functions.

(1) Time Variables. Operator shall be able to use predefined variables to represent time of day, day of the week, month of the year, and date. Other predefined variables or simple control logic shall provide elapsed time in seconds, minutes, hours, and days. Operator shall be able to start, stop, and reset elapsed time variables using the program language.

(2) System Variables. Operator shall be able to use predefined variables to represent status and results of controller software and shall be able to enable, disable, and change setpoints of Controller Software as described in Controller Software section.

2.28 CONTROLLER SOFTWARE

A. Building and energy management application software shall reside and operate in system controllers. Applications shall be editable through operator workstation, web browser interface, or engineering workstation.

B. Scheduling. System shall provide the following schedule options as a minimum:

1. Weekly. Provide separate schedules for each day of the week. Each schedule shall be able to include up to 5 occupied periods (5 start-stop pairs or 10 events).

2. Exception. Operator shall be able to designate an exception schedule for each of the next 365 days. After an exception schedule, has executed, system shall discard and replace exception schedule with standard schedule for that day of the week.

3. Holiday. Operator shall be able to define 24 special or holiday schedules of varying length on a scheduling calendar that repeats each year.

C. System Coordination. Operator shall be able to group related equipment based on function and location and to use these groups for scheduling and other applications.

D. Alarm Reporting.

E. Remote Communication. System shall automatically contact operator workstation or server on receipt of critical alarms.

F. Maintenance Management. System shall generate maintenance alarms when equipment exceeds adjustable runtime, equipment starts, or performance limits.

G. PID Control. System shall provide direct- and reverse-acting PID (proportional-integral-derivative) algorithms. Each algorithm shall have anti-windup and selectable controlled variable, setpoint, and PID gains. Each algorithm shall calculate a time-varying analog value that can be used to position an output or to stage a series of outputs.

H. Staggered Start. System shall stagger controlled equipment restart after power outage. Operator shall be able to adjust equipment restart order and time delay between equipment restarts.

I. Startup Optimization – All equipment noted in the sequences of operation to have scheduled operation shall be started on an optimized basis which attempts to reach occupied conditions just prior to the scheduled occupancy time.

J. Pressure control optimization – All equipment noted in the sequences of operation (fans and pumps) shall have reset of pressure control setpoint initiated in the sequence. Typically, for pumps this would cause the software to examine all connected control valves for position, determine the critical valve (defined as the valve at the highest demand position), and reset the pressure setpoint up or down to maintain the critical valve between 80 and 90% open. For fans serving zone air valves / VAV boxes, this would similarly reset the duct pressure setpoint to maintain the critical zone damper between 80 and 90% open.

K. Heating Water Pump Control – Whenever heating demand reaches a minimum controllable threshold; the heating pumps shall be disabled and the heating water system shut down until demand for heating / reheat reaches a controllable level. This shall apply only in non-critical environment, exclusions apply to medical and laboratory application.

L. Energy Calculations.

1. System shall accumulate and convert instantaneous power (kW) or flow rates (L/s [gpm]) to energy usage data.

2. System shall calculate a sliding-window average (rolling average). Operator shall be able to adjust window interval to 15 minutes, 30 minutes, or 60 minutes.

M. Anti-Short Cycling. Binary output objects shall be protected from short cycling by means of adjustable minimum on-time and off-time settings.

N. On and Off Control with Differential. System shall provide direct- and reverse-acting on and off algorithms with adjustable differential to cycle a binary output based on a controlled variable and setpoint.

O. Runtime Totalization. System shall provide an algorithm that can totalize runtime for each binary input and output. Operator shall be able to enable runtime alarm based on exceeded adjustable runtime limit. Configure and enable runtime totalization and alarms as specified.

2.29 CONTROLLERS

A. General. Provide controllers and accessory devices as required to achieve performance specified.

B. BACnet.

1. Building Controllers (BCs). Each BC shall conform to BACnet Building Controller (B-BC) device profile as specified in ANSI/ASHRAE 135-2016, and shall be listed as a certified B-BC in the BACnet Testing Laboratories (BTL) Product Listing.

2. Advanced Application Controllers (AACs). Each AAC shall conform to BACnet Advanced Application Controller (B-AAC) device profile as specified in ANSI/ASHRAE 135-2016, and shall be listed as a certified B-AAC in the BACnet Testing Laboratories (BTL) Product Listing.

3. Application Specific Controllers (ASCs). Each ASC shall conform to BACnet Application Specific Controller (B-ASC) device profile as specified in ANSI/ASHRAE 135-2016, and shall be listed as a certified B-ASC in the BACnet Testing Laboratories (BTL) Product Listing.

4. Smart Actuators (SAs). Each SA shall conform to BACnet Smart Actuator (B-SA) device profile as specified in ANSI/ASHRAE 135-2016, and shall be listed as a certified B-SA in the BACnet Testing Laboratories (BTL) Product Listing.

5. Smart Sensors (SSs). Each SS shall conform to BACnet Smart Sensor (B-SS) device profile as specified in ANSI/ASHRAE 135-2016, and shall be listed as a certified B-SS in the BACnet Testing Laboratories (BTL) Product Listing.

6. BACnet Communication.

a) Each BC shall reside on or be connected to a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing.

b) BACnet routing shall be performed by BCs or other BACnet device routers as necessary to connect BCs to networks of AACs and ASCs.

c) Each AAC shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.

d) Each ASC shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.

e) Each SA shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.

f) Each SS shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using ARCNET or MS/TP Data Link/Physical layer protocol.

C. Communication

1. Service Port. Each controller shall provide a service communication port for connection to a Portable Operator's Terminal. Connection shall be extended to space temperature sensor ports where shown on drawings.

2. Signal Management – Master or Global Controller operating systems shall manage input and output communication signals to allow distributed controllers (lower level networks) to share real and virtual object information and to allow for central monitoring and alarms.

3. Data Sharing. Each Master or Global Controller shall share data as required to allow the specified performance and sequence of operation.

4. Stand-Alone Operation. Each piece of equipment specified shall be controlled by a single controller to provide stand-alone control in the event of communication failure. All I/O points specified for a piece of equipment shall be integral to its controller. Provide stable and reliable stand-alone control using default values or other method for values normally read over the network.

D. Environment. Controller hardware shall be suitable for anticipated ambient conditions.

1. Controllers used outdoors or in wet ambient conditions shall be mounted in waterproof enclosures and shall be rated for operation at -29°C to 60°C (-20°F to 140°F).

2. Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).

E. Real-Time Clock. Controllers that perform scheduling shall have a real-time clock.

F. Serviceability

1. Controllers shall have diagnostic LEDs for power, communication, and processor.

2. Wires shall be connected to a field-removable modular terminal strip or to a termination card to allow service without rewiring the controller.

3. Each controller shall continually check its processor and memory circuit status and shall generate an alarm on abnormal operation. System shall continuously check controller network and generate alarm for each controller that fails to respond.

G. Immunity to Power and Noise. Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 hz and from keyed radios up to 5 W at 1 m (3 ft).

H. Transformer. ASC power supply shall be fused or current limiting and shall be rated at a minimum of 125% of ASC power consumption.

2.30 INPUT AND OUTPUT INTERFACE

A. General. Hard-wire input and output points to all controller hardware.

B. Protection. Shorting an input or output point to itself, to another point, or to ground shall cause no controller damage. Input or output point contact with up to 24 V for any duration shall cause no controller damage.

C. Binary Inputs. Binary inputs shall monitor the on and off signal from a remote device. Binary inputs shall provide a wetting current of at least 12 mA and shall be protected against contact bounce and noise. Binary inputs shall sense dry contact closure without application of power external to the controller.

D. Pulse Accumulation Inputs. Pulse accumulation inputs shall conform to binary input requirements and shall accumulate up to 10 pulses per second.

E. Analog Inputs. Analog inputs shall monitor low-voltage (0-10 Vdc), current (4-20 mA), or resistance (thermistor or RTD) signals. Analog inputs shall be compatible with and field configurable to commonly available sensing devices.

F. Binary Outputs. Binary outputs shall send an on-or-off signal for on and off control. Building Controller binary outputs shall have three-position (on-off-auto) override switches and status lights. Outputs shall be selectable for normally open or normally closed operation.

G. Analog Outputs. Analog outputs shall send a modulating 0-10 Vdc or 4-20 mA signal as required to properly control output devices. Each Building Controller analog output shall have a two-position (auto-manual) switch, a manually adjustable potentiometer, and status lights. Analog outputs shall not drift more than 0.4% of range annually.

H. Tri-State Outputs. Control three-point floating electronic actuators without feedback with tri-state outputs (two coordinated binary outputs). Tri-State outputs may be used to provide analog output control in zone control and terminal unit control applications such as VAV terminal units, duct-mounted heating coils, and zone dampers.

I. Universal Inputs and Outputs. Inputs and outputs that can be designated as either binary or analog in software shall conform to the provisions of this section that are appropriate for their designated use.

2.31 POWER SUPPLIES AND LINE FILTERING

A. Power Supplies. Control transformers shall be UL listed. Furnish Class 2 current-limiting type or furnish over-current protection in primary and secondary circuits for Class 2 service in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.

1. DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100-microsecond response time for 50% load changes. Unit shall have built-in over-voltage and over-current protection and shall be able to withstand 150% current overload for at least three seconds without trip-out or failure.

a) Unit shall operate between 0°C and 50°C (32°F and 120°F). EM/RF shall meet FCC Class B and VDE 0871 for Class B and MILSTD 810C for shock and vibration.

b) Line voltage units shall be UL recognized and CSA listed.

B. Power Line Filtering

1. Provide internal or external transient voltage and surge suppression for workstations and controllers. Surge protection shall have:

a) Dielectric strength of 1000 V minimum

b) Response time of 10 nanoseconds or less

c) Transverse mode noise attenuation of 65 dB or greater

d) Common mode noise attenuation of 150 dB or greater at 40-100 Hz

3.0 PART 3 - EXECUTION

3.1 WIRING

A. All wiring shall comply with these specifications, Specification Section 230514, and the NEC. Deviations are only permitted where manufacturer's requirements specifically conflict with gauge and wiring type specified within this section.

B. Communication wiring shall be installed using the particular system recommended, plenum rated, jacket shielded cable. The communication network wiring shall be clearly marked with a specific color code. Communication wiring shall not be installed near noise producing equipment, such as ballasts, magnetic starters, etc. Communication wiring shall comply with the optimum requirements necessary to assure communication integrity and speed.

C. All analog inputs and analog outputs shall be wired using 18 gauge stranded shielded cable. All Analog inputs and analog outputs wiring shall not be installed near noise producing equipment, such as ballasts, magnetic starters, etc.

D. All digital outputs shall be wired using 18 gauge stranded wire.

E. All wiring in mechanical rooms, walls shall be installed in EMT conduit. Concealed conduit and wiring is required in all finished spaces.

F. Power Supplies

1. Transformers – Each w/ low voltage fuse holder/disconnect

2. Actuators and relays shall use separate transformers from those powering microprocessor control panels.

3. Transformers shall be sized for a minimum of 150% of the connected load.

4. Convenience Outlet –

   a. 110vac combination outlet w/ switch to kill 110vac to panel

5. Switched 110vac to panel is fused before transformers (after outlet).

6. Provide at all control panels excepting those for terminal equipment (exclude reheats, cabinet heaters, fan coils, etc.)

7. Wiring Panduit

   a. Wire ducts around exterior of panel for cables entering panel

   b. Wire ducts as necessary to route hookup wires from terminals to controllers and other devices

8. Panel Construction (sized to provide 25% future expansion w/ removable back panel)

   a. Indoors – Johnson M8100 series

   b. Outdoors – Hoffman fiberglass Nema 4x

9. Wire Labeling

   a. All DDC system wiring shall be individually labeled and permanently tagged at both ends of the conductors, including within all junction boxes between panels.

   b. All submittal and as-built drawings shall reflect the field installed wire tag numbers.

   c. All wire numbers shall be unique throughout the system installation.

3.2 DDC EQUIPMENT

A. All components shall be installed in protective enclosures. All wiring within the DDC enclosure shall be number coded. Both the enclosure and the controller shall be properly grounded in accordance with manufacturer's recommendation. Documentation shall be firmly attached to the enclosure within a plastic envelope. Documentation shall state point-to-point termination detail, description of each individual point, location of power source for the controller and ID number or address within the network.

B. All DDC Controllers shall be mounted on walls within equipment rooms, custodial closets or electrical rooms. Only application-specific controllers for rooftop units or package units may be mounted on the equipment.

3.3 EXAMINATION

A. Thoroughly examine project plans for control device and equipment locations. Report discrepancies, conflicts, or omissions to Architect or Engineer for resolution before starting rough-in work.

B. Inspect site to verify that equipment can be installed as shown. Report discrepancies, conflicts, or omissions to Engineer for resolution before starting rough-in work.

C. Examine drawings and specifications for work of others. Report inadequate headroom or space conditions or other discrepancies to Engineer and obtain written instructions for changes necessary to accommodate work of others. Temperature Controls Contractor shall perform at his expense necessary changes in specified work caused by failure or neglect to report discrepancies.

3.4 PROTECTION

A. Temperature Controls Contractor shall protect against and be liable for damage to work and to material caused by Contractor's work or employees.

B. Temperature Controls Contractor shall be responsible for work and equipment until inspected, tested, and accepted. Protect material not immediately installed. Close open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.5 COORDINATION

A. Site.

1. Assist in coordinating space conditions to accommodate the work of each trade where work will be installed near or will interfere with work of other trades. If installation without coordination causes interference with work of other trades, Contractor shall correct conditions without extra charge.

2. Coordinate and schedule work with other work in the same area and with work dependent upon other work to facilitate mutual progress.

B. Test and Balance.

1. Furnish Test and Balance Contractor a single set of necessary tools to interface to control system for testing and balancing for the duration of TAB activity

2. Train Test and Balance Contractor to use control system interface tools.

3. Provide a qualified technician to assist with testing and balancing of all air handling equipment and terminal units.

4. Test and Balance Contractor shall return tools undamaged and in working condition at completion of testing and balancing.

C. Life Safety.

1. Duct smoke detectors required for air handler shutdown are furnished and installed by others. Interlock smoke detectors to air handlers for shutdown as specified Sequence of Operations for HVAC Controls.

2. Smoke dampers and actuators required for duct smoke isolation are furnished and installed by others. Interlock smoke dampers to air handlers as specified in Sequence of Operations for HVAC Controls.

D. Coordination with Other Controls. Integrate with and coordinate controls and control devices furnished or installed by others as follows.

1. Each supplier of a controls product shall configure, program, start up, and test that product to meet the required sequences of operation regardless of where within the contract documents those products are described.

2. Coordinate and resolve incompatibility issues that arise between control products provided under this section and those provided under other sections or divisions of this specification.

3. Temperature Controls Contractor shall be responsible for integration of control products provided by multiple suppliers regardless of where integration is described within the contract documents.

3.6 GENERAL WORKMANSHIP

A. Install equipment, piping, and wiring or raceway horizontally, vertically, and parallel to walls wherever possible.

B. Independently support all temperature control wiring from other systems. Do NOT support from conduits, piping or hangers for equipment.

C. Provide sufficient slack and flexible connections to allow for piping and equipment vibration isolation.

D. Install equipment in readily accessible locations as defined by National Electrical Code (NEC) Chapter 1 Article 100 Part A.

E. Verify wiring integrity to ensure continuity and freedom from shorts and ground faults.

F. Equipment, installation, and wiring shall comply with industry specifications and standards and local codes for performance, reliability, and compatibility.

3.7 FIELD QUALITY CONTROL

A. Work, materials, and equipment shall comply with rules and regulations of applicable local, state, and federal codes and ordinances.

B. Continually monitor field installation for code compliance and workmanship quality.

C. Contractor shall arrange for work inspection by local or state authorities having jurisdiction over the work.

3.8 COMMUNICATION WIRING

A. Install communication wiring in separate raceways and enclosures from other Class 2 wiring.

B. During installation do not exceed maximum cable pulling, tension, or bend radius specified by the cable manufacturer.

C. Verify entire network's integrity following cable installation using appropriate tests for each cable.

D. Install lightning arrestor according to manufacturer's recommendations between cable and ground where a cable enters or exits a building.

E. Each run of communication wiring shall be a continuous length without splices when that length is commercially available. Runs longer than commercially available lengths shall have as few splices as possible using commercially available lengths.

F. Label communication wiring to indicate origination and destination.

3.9 INSTALLATION OF SENSORS

A. Install sensors according to manufacturer's recommendations.

B. Mount sensors rigidly and adequately for operating environment.

C. Install room temperature sensors on concealed junction boxes properly supported by wall framing. Where sensor locations can be effected by wall surface temperature, pack junction box with insulation and provide insulated back plate for sensor. Install all space sensors so they are not affected by direct sunlight, appliances / equipment, or air currents. Consult with the Engineer prior to installing device if the location shown on the project drawings does not meet these criteria.

D. Air seal wires attached to sensors in their raceways or in the wall to prevent sensor readings from being affected by air transmitted from other areas. Use of Silicon or similar sealant is prohibited. Use Fiberglass or poly fill in the junction boxes.

E. Use averaging sensors in mixing plenums and hot and cold decks, and all duct locations which may be subject to stratification. Install averaging sensors in a serpentine manner vertically across duct. Support each bend with a mechanically fastened capillary clip. "Stick on" type fasteners are specifically prohibited.

F. Install mixing plenum low-limit sensors in a serpentine manner horizontally across duct. Support each bend with a mechanically fastened capillary clip. "Stick on" type fasteners are specifically prohibited.

G. Install pipe-mounted temperature sensors in wells. Install liquid temperature sensors with heat-conducting fluid in thermal wells. Sensors and wells shall be installed to assure that the entire sensing element is completely immersed in the measured media with minimal pressure drop. Provide oversized pipe section, oversized elbow, or other recognized method to achieve this result in compliance with this specification and manufacturer's recommendations.

H. Install outdoor air temperature sensors on north wall with sun shield. Sensor to be located where thermal characteristics of the building and solar load do not effect readings.

I. All sensors to be mounted on externally insulated ductwork or plenums shall be provided with standoff brackets. Insulation and vapor barriers shall be carried continuously beneath the sensor enclosure. Coordinate installation with mechanical and insulation contractors.

J. Differential Air Static Pressure.

1. Piping to pressure transducer pressure ports shall contain a capped test port adjacent to transducer.

2. Air Pressure Transducers – Mount in a vibration free location accessible for service without use of ladders or special equipment.

3. Mount gauge tees adjacent to air and water differential pressure taps. Install shut-off valves before tee for water gauges.

K. Smoke detectors, freezestats, high-pressure cut-offs, and other safety switches shall be hard-wired to de-energize equipment as described in the sequence of operation. Switches shall require manual reset. Provide contacts that allow DDC software to monitor safety switch status. Interlock shall be provided such that the unit cannot be restarted in either hand or auto modes without manual reset of the safety device.

3.10 FLOW SWITCH INSTALLATION

A. Use correct paddle for pipe diameter.

B. Adjust flow switch according to manufacturer's instructions.

3.11 FLOW TRANSMITTER INSTALLATION

A. Airflow and Liquid Flow

1. Provide meter probe size, type and arrangement per manufacturers recommendations to obtain accuracy and performance specified.

2. Verify calibration of Remote Readout Unit (where specified to be provided) over operating range in conjunction with TAB contractor. Perform all necessary field calibration to obtain readout accuracy within specified limits.

3. Provide specified interface to DDC system.

4. Verify accuracy of DDC system reading against Remote Readout Unit (where specified) and balancer readings over operating range of device.

5. Provide installation in strict compliance with manufacturer’s requirements.

3.12 ACTUATORS

A. General. Mount actuators and adapters according to manufacturer's recommendations.

B. Electric and Electronic Damper Actuators. Mount actuators directly on damper shaft or jackshaft unless shown as a linkage installation. Link actuators according to manufacturer's recommendations.

1. For low-leakage dampers with seals, mount actuator with a minimum 5° travel available for damper seal tightening.

2. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, then tighten linkage.

3. Check operation of damper-actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.

4. Provide necessary mounting hardware and linkages for actuator installation.

C. Valve Actuators. Connect actuators to valves with adapters approved by actuator manufacturer.

D. Where actuators are mounted to the side of insulated ductwork or equipment, provide insulation standoffs and repair insulation and vapor barrier.

3.13 WARNING LABELS

A. Affix permanent warning labels to equipment that can be automatically started by the control system.

1. Labels shall use white lettering (12-point type or larger) on a red background.

2. Warning labels shall read as follows.

C A U T I O N
This equipment is operating under automatic control and may start or stop at any time without warning. Switch disconnect to "Off" position before servicing.

B. Affix permanent warning labels to motor starters and control panels that are connected to multiple power sources utilizing separate disconnects.

1. Labels shall use white lettering (12-point type or larger) on a red background.

2. Warning labels shall read as follows.

C A U T I O N
This equipment is fed from more than one power source with separate disconnects. Disconnect all power sources before servicing.

3.14 IDENTIFICATION OF HARDWARE AND WIRING

A. Label wiring and cabling, including that within factory-fabricated panels, with control system address or termination number at each end within 2 in. of termination.

B. Permanently label or code each point of field terminal strips to show instrument or item served.

C. Label control panels with minimum ½ in. letters on laminated plastic nameplates.

D. Label each control component with a permanent label. Label plug-in components such that label remains stationary during component replacement.

E. Label room sensors related to terminal boxes or valves with nameplates.

F. Manufacturers' nameplates and UL or CSA labels shall be visible and legible after equipment is installed.

G. Label identifiers shall match record documents.

H. Provide laminated control diagrams in each control panel for each piece of major controlled equipment or system.

3.15 OPERATOR INTERFACE

A. Standard Graphics. Provide graphics as specified. Show on each equipment graphic input and output points and relevant calculated points such as indicated on the applicable Points List / diagram. Point information on graphics shall dynamically update.

B. Install, initialize, start up, and troubleshoot operator interface software and functions (including operating system software, operator interface database, and third-party software installation and integration required for successful operator interface operation).

C. Provide logical descriptions and engineering units on all data displays. Example: percentage position shall be easily discernable as percent open or closed.

D. Provide logical linking between graphics. For example, direct penetration from building to floor to air handler to air terminal and back is to be provided without need to resort to a menu tree to navigate the building.

E. Graphical user interface shall be reviewed by the Owner and / or Engineer. If in their sole opinion the graphics are inaccurate, incomplete, or improperly represent the systems, the graphics shall be updated as no additional cost to the project.

3.16 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

A. Prior to demonstration and acceptance, the contractor shall:

1. Complete all Pre-Commissioning requirements as described in paragraph 1.11 of this section.

2. Complete system commissioning requirements per section 019113.

3. Correct all deficiencies in control system hardware and software noted in engineer's punchlists, field observations, and commissioning issues logs / reports.

B. Demonstration. Prior to acceptance, perform the following to demonstrate system operation and compliance.

1. Engineer and / or Owner's representative will be present to observe and review system demonstration. Notify Engineer at least 10 days before system demonstration begins.

2. Demonstrate actual field operation of sequence of operation. Provide at least two persons equipped with two-way communication (if required). Demonstrate calibration and response of any input and output points requested by Engineer. Provide and operate test equipment required to prove proper system operation. Engineer may, at their discretion, perform these tests on a "spot check" basis.

3. Demonstrate complete operation of operator interface.

4. Demonstrate each of the following.

a. DDC loop response. Supply graphical trend data output showing each DDC loop's response to a setpoint change representing an actuator position change of at least 25% of full range. Trend sampling rate shall be from 10 seconds to 3 minutes, depending on loop speed. Each sample's trend data shall show setpoint, actuator position, and controlled variable values. Engineer will require further tuning of each loop that displays unreasonably under- or over-damped control.

b. Demand limiting (where applicable). Supply trend data output showing demand-limiting algorithm action. Trend data shall document action sampled each minute over at least a 30-minute period and shall show building kW, demand-limiting setpoint, and status of setpoints and other affected equipment parameters.

c. Building fire alarm system interface.

d. Trend logs for each system. Trend data shall indicate setpoints, operating points, valve positions, and other data as specified in the points list provided with each sequence of operation.. Each log shall cover three 48-hour periods and shall have a sample frequency not less than 10 minutes or as specified on its points list. Logs shall be accessible through system's operator interface and shall be retrievable for use in other software programs.

5. Tests that fail to demonstrate proper system operation shall be repeated after Contractor makes necessary repairs or revisions to hardware or software to successfully complete each test.

C. Acceptance.

1. After tests described in these specifications are performed to the satisfaction of both Engineer and Owner, Engineer will accept control system as meeting completion requirements. Engineer may exempt tests from completion requirements that cannot be performed due to circumstances beyond Contractor's control, such as seasonal requirements or construction progress issues. Engineer will provide written statement of each exempted test. Exempted tests shall be performed as part of warranty.

3.17 CLEANING

A. Each day clean up debris resulting from work. Remove packaging material as soon as its contents have been removed. Collect waste and place in designated location.

B. On completion of work in each area, clean work debris and equipment. Keep areas free from dust, dirt, and debris.

C. On completion of work, check equipment furnished under this section for paint damage. Repair damaged factory-finished paint to match adjacent areas. Replace deformed cabinets and enclosures with new material and repaint to match adjacent areas.

END OF SECTION 230923

SECTION 232000 - PIPING SYSTEMS AND ACCESSORIES

1.0 PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services as required for the complete installation designed in Contract Documents.

B. Provide all chemical treatment required for piping systems each time an individual system is drained and then refilled as a result of work performed under this contract.

1.2 RELATED DOCUMENTS

A. All work under this section is subject to the Contract Documents and this Contractor shall be responsible for and governed by all the requirements therein.

1.3 SUBMITTALS

A. Submit a schedule of pipe materials, fittings and connections by piping system.

B. Submit refrigerant piping diagram.

C. Submit anchors, sleeves, hanger shields, and guides.

1.4 QUALITY ASSURANCE

A. Manufacturer: Provide domestically manufactured pipe, fittings and accessories.

B. All pipe, tubing and fittings shall be either tested by an approved third party testing agency or certified by an approved third party certification agency.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver products in factory-fabricated containers. Deliver pipe and tube with factory-applied plastic end-caps on each length.

B. Store products in original wrapping and protect from dirt and damage. Store piping and tube inside. Where necessary to store outside, evaluate well above grade and enclose with waterproof wrapping.

C. Handle products carefully to avoid damage. Do not install damaged products.

2.0 PART 2 - PRODUCTS

2.1 GENERAL

A. Each length of pipe and each pipe fitting shall be new and marked with manufacturer's name; complying with the following Standards where applicable:

1. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)

2. American Society of Mechanical Engineers (ASME)

3. American Society of Testing and Materials (ASTM)

4. American National Standards Institute (ANSI)

5. American Water Works Association (AWWA)

6. American Petroleum Institute (API)

7. American Standards Association (ASA)

B. Refer to the MCNYS section 1202 for additional compliance standards for piping and fittings.

C. Refer to the MCNYS section 1210 for piping requirements specific to ground source Heat Pump Loops.

2.2 STEEL PIPING AND FITTINGS

A. Pipe: ASTM A53, ASTM A106, Schedule 40 weight as specified as Exhibit “A”; black or galvanized finish as specified in Exhibit ‘A’ or as noted on drawings; ends chamfered for welding mechanical connections. Galvanizing on piping shall be in compliance with ASTM A123.

B. Fittings: Same material and pressure class as adjoining pipe.

1. Welded fittings: Same weight as adjoining piping, factory forged, seamless construction, butt weld type, chamfered ends, in compliance with ASTM A105, ANSI/ASME B16.9 and MSS SP-43. Socket weld, Class 3000, forged in compliance with ASTM A105 and ASME B16.11. Where branch connections are two or more sizes smaller than main size, "Weldolets", Class 3000, forged, in compliance with ASTM A105, ANSI/ASME B16.9 and MSS SP-97, "Threadolets", Class 3000, forged, in compliance with ASTM A105, ASME B16.11, ANSI/ASME B1.20.1 and MSS SP-97. Sockolet weld type, Class 3000, forged in compliance with ASTM A105, ASME B16.11 and MSS SP-97 where specified in Exhibit ‘A’.

2. Screwed fittings: Malleable iron, black or galvanized, as called for in Exhibit ‘A’ or as noted on the Drawings. Fittings shall be in compliance with ASTM A197, ANSI/ASME B1.20.1 and ASME B16.3. Galvanizing of fittings sha11 be in compliance with ASME A153.

3. Malleable iron fitting shall be Standard Class 150 unless otherwise specified in Exhibit ‘A’ to be Extra Heavy Class 300.

4. Mitered elbows, "shaped" nipples, and job fabricated reductions are not acceptable unless specifically called for.

C. Flanges, Unions and Couplings:

1. Unions: For sizes 2 in. and smaller - Malleable iron, bronze to iron seat, Class 300 in compliance with ASTM A197, ANSI/ASME B1.20.1 and ASME B16.39, or Class 3000 forged steel, steel to steel ground joint to ASTM A181, ANSI/ASME and B1.20.1. MSS SP-83 as called for in Exhibit ‘A’. Galvanizing on the unions sha11 be in compliance with ASME A153.

2. Flanges: For sizes 2-1/2 in. and larger pipe sizes - Welding neck type, forged, in compliance with ASTM A105 and ASME B16.5. Class 150 or Class 300 as called for in Exhibit ‘A’.

3. Flange Gaskets: All flange gaskets shall be Flexitallic Thermculite Type 835 Spiral Wound.

D. Cleanouts, gauge and instrument connections, nipples and plugs, for adapting gauges and instruments to piping system shall be IPS brass.

E. Base Elbows:

1. Cast iron or steel type, flange connections; Crane 500 or equivalent. Made from welding elbows, with welded pipe support and steel base. Reducing elbows where necessary.

Elbow Size	Support Size	Base Plate
To 3 in.	1-1/4 in.	6 in. x 6 in. x 1/4 in.
4 in. to 6 in.	2-1/2 in.	8 in. x 8 in. x 1/4 in.
6 in. and larger	6 in.	14 in. x 14 in. x 5/16 in.

2. Anchor bolt holes in each corner of base for securely bolting to floor or concrete base; minimum 3/4 in. bolts.

2.3 COPPER PIPE, SOLDER FITTINGS

A. Tubing (Type L “pipe”): Hard temper meeting in compliance with ASTM B75 and ASTM B88; Type L, M. as called for in Exhibit ‘A’ or as noted on the Drawings. Soft temper only as called for in Exhibit ‘A’ or as noted on the Drawings. Plans show copper tube sizes.

B. Fittings (Tees, Elbows, Reducers, etc.): Wrought copper or cast bronze as called for in Exhibit ‘A’ or as noted on the Drawings; solder end connections; shall meet applicable and applicable ASME B16.22 or ASME B16.18.

C. Fittings (Tees, Elbows, Reducers, etc.): Cast bronze, threaded end connections, in compliance with ASME B16.15 and ANSI/ASME B1.20.1.

D. Fittings (Tees, Elbows, Reducers, etc.): Wrought copper or cast copper alloy drainage fitting (DWV), solder end connections, in compliance with ASME B16.29 or ASTM B23.

E. Unions and Flanges: 2 in. and smaller use unions, solder type, cast copper alloy or wrought copper alloy, metal to metal meeting surface, 150 lb. swp, in compliance with ASME B16.18 or ASME B16.22, ANSI/ASME B1.20.1. For piping 2-1/2 in. and over use flanges, cast copper alloy, companion type, Class 150, in compliance with ASME B16.24.

F. Solder Materials: No-lead solder, using alloys made from tin, copper, silver and nickel.

1. Make: Harris "Stay-Safe 50" and "Bright", Englehart "Silverbright 100", Willard Industries "Solder Safe (silver bearing), Canfield "Watersafe".

2.4 COPPER PIPE AND BRAZED FITTINGS

A. Tubing (Type L): Hard temper in compliance with ASTM B75 and ASTM B88. As called for in Exhibit ‘A’ or as noted on the Drawings.

B. Fittings (Tees, Elbows, Reducers, etc.): Wrought copper or cast bronze as called for in Exhibit ‘A’ or as noted on the Drawings; solder end connections; shall meet applicable and applicable ASME B16.22 or ASME B16.18.

C. Unions and Flanges: 2 in. and smaller use unions, solder type, cast copper alloy or wrought copper alloy, metal to metal meeting surface, 150 lb. swp, in compliance with ASME B16.18 or ASME B16.22, ANSI/ASME B1.20.1. For piping 2-1/2 in. and over use flanges, cast copper alloy, companion type, Class 150, in compliance with ASME B16.24.

D. Brazing Materials: Silver Alloy, Airco Sil-4S or Sil-Fos as called for in Exhibit ‘A’ or as noted on the Drawings.

2.5 DIELECTRIC PIPE FITTINGS

A. Where dissimilar metals are encountered, provide brass valve between steel and copper connection points.

2.6 REFRIGERATION PIPING

A. Type L hard temper deoxidized, dehydrated, and sealed copper tubing, refrigerant grade.

B. Refrigerant grade wrought copper fittings. Long radius elbows.

C. Factory made suction traps, Melco Type PT.

D. Piping and system shall meet the requirements of Mechanical Refrigeration Safety Code, ANSI B9.1.

E. Refer to additional requirements in this specification for TYPE L hard copper tubing and fittings.

F. Make: Alco, Detroit, Henry, Mueller, Sporlan.

2.7 REFRIGERATION TUBING (Sizes ¾" or below)

A. Type ACR seamless, deoxidized, dehydrated, and sealed copper tubing.

B. Straight length tubing to be used for straight runs, coiled tubing may be used at final connections.

C. Tubing up to ¾" may have radius bent elbows, field fabricated at no less than manufacturer's minimum recommended bend radius using tools specifically recommended for the application.

D. Refrigerant grade type ACR copper fittings. Long radius elbows.

E. Factory made suction traps, Melco Type PT.

F. Piping and system shall meet the requirements of Mechanical Refrigeration Safety Code, ANSI B9.1.

G. Make: Reftekk, Everbilt, Mueller.

2.8 HANGERS, INSERTS AND SUPPORTS

A. Hangers, Inserts, Clamps: Carpenter and Patterson, Central Iron, Fee and Mason, ITT Gruvlok.

B. Hangers:

1. Adjustable, wrought malleable iron or steel. Copper plated or PVC coated where in contact with copper piping. Cadmium plated or galvanized for exterior.

2. Adjustable ring type where piping is installed directly on hanger for piping 3 in. and smaller.

3. Adjustable steel clevis type for piping 4 in. and larger, and where insulation passes through hanger.

4. Hangers sized to permit passage of continuous insulation through the hanger.

5. Nuts and rods with electroplated zinc or cadmium (0.005 in. minimum) finish.

C. Hanger Shields:

1. Pre-insulated type:

a) To be used where direct firm support and / or load restraint of piping system required while insulation system maintained. Includes, but not limited to riser clamps, pipe guides and seismic restraint points. May be used for general support at hanger or trapeze locations at contractor option.

b) To be used where anticipated pipe surface temperatures may exceed 800 degrees on a consistent basis.

c) Insulated pipes shall be protected at point of support by a 360° insert of high density, 100 psi waterproofed calcium silicate, encased in a 360° sheet metal shield. Insulation insert to be same thickness as adjoining pipe insulation and extend 1 in. beyond sheet metal shield

2. Field-insulated type:

a) #18 USSG, galvanized steel shields, minimum 120° arc. Provide temporary blocking between pipe and hanger to maintain proper spacing for insulation. Provide at all support points.

3. Shield Sizing:

Pipe Size	Shield ID (1 ½" insulation)	Shield Length	Minimum Gauge
Up to 3-1/2"	Up to 6.5"	12 in.	18
4"	7"	12 in.	16
5" and 6"	8" and 9"	12 in.	14
8" to 14"	11" to 17"	24 in.	12
16" to 24"	19" to 27"	24 in.	10

a) Hanger shield gauges listed are for use with band type hangers only. For point loading (roller support), increase shield thickness by one gauge, and length by 50%.

D. Spacing Schedule: Hanger spacing shall be per the following tables. For alternate materials and sizes not listed herein, refer to the MCNYS, Section 305

Pipe Size	Steel	Copper	PVC Plastic	Rod Size
½ to 1 in.	8 ft.	6 ft.	3 ft.	3/8 in.
1 ¼ to 2 in.	10 ft.	6 ft.	3 ft.	3/8 in.
2 ½ to 4 in.	12 ft.	10 ft.	4 ft.	1/2 in.
5 and 6 in.	12 ft.	10 ft.	4 ft.	5/8 in.
8 in.	12 ft.	10 ft.	4 ft.	3/4 in.
Over 8 in.	To suit loading conditions			

E. Inserts: Provide high density fiberglass or calcium silicate piping inserts to eliminate compression of pipe insulation system, full length of specified piping shield, by pipe size.

1. Make: "H-Block" by ICA, Inc., TPS / TPSX by SPI, or approved equal.

F. Supports:

1. For weights under 1000 lbs.: "Drill-In" inserts equivalent to Phillips "Red Head," "U-Channel," "Unistrut," beam clamps or other structurally reviewed support. The factor of safety shall be at least four. Follow manufacturer's recommendations.

2. For weights above 1000 lbs.: Drill through floor slabs and provide flat flush plate welded to top of rod or provide additional "Drill-In" inserts and hangers to reduce load per hanger below 1000 lbs. The factor of safety shall be at least four.

3. For metal decks: Drill hole through for hanger rods and imbed a welded plate in concrete or use Phillips "Red Head" devices designed for this application, with a safety factor of four.

2.9 PIPING ACCESSORIES

A. Escutcheon Plates: Steel or cast iron polished chrome, split hinge type with setscrew, high plates where required for extended sleeves.

B. Pipe Guides: Cylindrical steel guide sleeve, proper length for travel, integral bottom base anchor; top half removable. Split steel spider to bolt to pipe, copper plated spider for copper pipe. Space between sleeve and spider to allow for insulation where required. Make: Anaconda, Flexonics, Pipe Shields, Keflex, or equal.

C. Anchors: Same material as pipe. Make: Keflex, Flexonics, Pipe Shields, or field constructed.

D. Pipe Roll Stand: Cast iron roll stand. Make: Advanced Thermal Systems, Carpenter and Patterson, ITT Gruvlok, Pipe Shields.

2.10 SLEEVES

A. Standard Type:

1. Schedule 40 black steel pipe sleeves, two pipe sizes larger than the pipe, for structural surfaces (bearing walls, structural slabs, beams and other structural surfaces) and where called for.

2. Sheet metal sleeves for nonstructural surfaces and existing construction. Sheet metal sleeves shall be 18 gauge minimum and braced to prevent collapsing.

B. Pre-Insulated Type:

1. Adjustable or fixed length metal cans, 24 gauge minimum, sized for 1 in. spacing between insulation and can. Insulation shall consist of a 360° waterproofed calcium silicate insert sized to extend 1 in. beyond wall or floor penetration. Calcium silicate insert shall be same thickness as adjoining pipe insulation. Spacing between shield and can packed at each end with double neoprene coated rope positively fastened.

2.11 SEALING ELEMENTS

A. Waterproof Type:

1. Exterior walls, below grade, above floor: Synthetic rubber material with zinc plated bolts.

2. Acceptable Make: "Link-Seal" Series 200, 300 or 400, Pyropac, Calipco.

2.12 FIRESTOP SYSTEM FOR OPENINGS THROUGH FIRE RATED WALL FLOOR ASSEMBLIES

A. Materials for firestopping seals shall be listed by an approved independent testing laboratory for "Through-Penetration Firestop Systems". The system shall meet the standard fire test for Through-Penetration Firestop Systems designated ASTM E814. Firestop system seals shall be provided at locations where piping passes through fire rated wall, floor/ceiling, or ceiling/roof assembly. Minimum required fire resistant ratings of the assembly shall be maintained by the Firestop System. Installation shall conform to the manufacturer's recommendations and other requirements necessary to meet the testing laboratory's listing for the specific installation.

2.13 FLEXIBLE “U” EXPANSION LOOPS

A. Copper Piping Systems 2” and Under (Soldered End Connection):

1. Hose and Braid: Bronze.
2. Elbows and Spool: Copper.
3. End Connections: Copper female soldered ends.
4. Minimum Travel: +/- 4”
5. Minimum operating pressure of 150 psi at operating temperature of 250°F.
6. Provide drain connection and support bracket at 180° return bend.
7. Provide guides and anchors in strict compliance with manufacturer’s requirements.
8. Design Equipment: Metraflex Model MLS8.
9. Acceptable Makes: Metraflex Model MLS8, Flex Hose “Tri-Flex Loop” Model TFL BSW, Flexicraft Model ML, Kinetics Model EUS.

B. Steel Piping Systems 10” and Under (Threaded, Flanged, Butt Welded End Connections):

1. Hose and Braid: Type 304 stainless steel.
2. Elbows: Sch. 40 carbon steel.
3. End Connections: Sch. 40 carbon steel flanged, butt welded.
4. Travel: ±4”.
5. Provide drain connection and support bracket at 180° return bend.
6. Minimum operating pressure of 150 psi at operating temperature of 200°F.
7. Provide guides and anchors in strict compliance with manufacturer’s requirements.

8. Design Equipment: Metraflex Model MLT8 (threaded), Model MLF8 (flanged), Model MLW8 (welded).

9. Acceptable Makes: Metraflex Model MLT8 (threaded), Model MLF8 (flanged), Model MLW8 (welded), Flexicraft Model ML, Kinetics Model EUT (threaded), Model EUF (flanged), Model EUW (welded), Flex Hose “Tri-Flex Loop” TFLSMN (threaded), Flex Hose “Tri-Flex Loop” TFLSMP (Flanged)

2.14 PIPING MATERIALS AND SCHEDULE

A. See Exhibit "A," "Schedule of Piping Materials" at end of this Section for (HVAC) piping.

3.0 PART 3 - EXECUTION

3.1 INSTALLATION

A. Install pipe, tube and fittings in accordance with recognized industry practices which will achieve permanently leak proof piping systems, capable of performing each indicated service without piping failure. Install each run with a minimum of joints and couplings, but with adequate accessible unions and flanges for disassembly and maintenance/replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connections, with 1/16" misalignment tolerance.

B. Locate piping runs, except as otherwise indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. Locate runs as indicated or described by diagrams, details and notations or, if not otherwise indicated, run piping in the shortest route which does not obstruct usable space or block access for servicing the building and equipment. Hold piping close to walls, overhead construction, columns and other structural and permanent enclosure elements of the building. Limit clearance to 1.0" where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any. Wherever possible, in finished and occupied spaces, conceal piping from view, by locating in column enclosures, in hollow wall construction or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as indicated.

C. Space pipe supports, arrange reducers, and pitch piping to allow air to be vented to system high points and to allow the system to be drained at the low points, and wherever required to permit complete draining of all lines.

D. Make all changes in size and direction of piping with fittings, except for soft copper tubing, use tubing bender.

E. Install piping to valves, strainers, pumps and other equipment at full line size. Where reduction or increase in size is required, make it with a fitting at the equipment connection.

F. Air Vents: Provide manual air vents at high points in piping system and where indicated on the drawings.

G. Drain Valves: Provide manual drain valves at low points in piping system and where indicated on the drawings.

H. All piping located in chases, soffits or other elements of construction which is not accessible by access doors or ceiling tile removal shall be welded, brazed or soldered. Mechanical coupling are not permitted.

3.2 EQUIPMENT AND SYSTEMS

A. Equipment and systems in accordance with laws, codes, and provisions of each applicable section of these specifications. Accurately establish grade and elevation of piping before setting sleeves. Install piping without springing or forcing (except where specifically called for), making proper allowance for expansion and anchoring. Arrange piping at equipment with necessary offsets, unions, flanges, valves, to allow for easy part removal and maintenance. Offset piping and change elevation as required for coordination with other work. Avoid contact with other mechanical or electrical systems. Provide adequate means of draining and venting units, risers, circuits and systems. Conceal piping unless otherwise called for. Ream pipes after cutting and clean before installing. Cap or plug equipment and pipe openings during construction. Install piping parallel with lines of building, properly spaced to provide clearance for insulation. Make changes in direction and branch connections with fittings. Do not install valves, unions and flanges in inaccessible locations. Provide trap seal of adequate depth on drain pans.

3.3 WATER SYSTEMS

A. Top connection for upfeed, bottom or side connection for downfeed. Grade off-level; up in direction of flow and down toward drain.

3.4 REFRIGERATION PIPING AND TESTING

A. Refrigeration piping schematics shall be developed in collaboration with the proposed / submitted equipment manufacturer and reflect all necessary details specific to the project requirements. Sizing, where present on the drawings, shall be confirmed and modified to conform in all respects at no additional cost to the project.

B. Fittings brazed with silver brazing alloy. Guarantee refrigerant charge for one year from date of final acceptance. Provide for flexibility at compressor connections. Piping and system shall meet the requirements of Mechanical Refrigeration Safety Code, ANSI B9.1. Clean piping, then pump-down and evacuate systems with high grade vacuum pump. Unless otherwise recommended by manufacturer, evacuate system to 0.1 in. VAC, break vacuum with dry nitrogen, re-evacuate to 0.1 in. VAC and hold for four hours; then charge system. Charge with refrigerant as recommended by manufacturer.

3.5 HANGERS, INSERTS AND SUPPORTS

A. Piping shall not be supported by wires, band iron, chains, vertical expansion bolts or from other piping. Support each pipe with individual hangers from concrete inserts, welded supports, or beam clamps of proper configuration and loading design requirements for each location. Trapeze hangers are acceptable for racking of multiple pipes of 1-1/2" or less in size. Follow manufacturer's safe loading recommendations. Suspend with rods of sufficient length for swing and of size as called for, using four nuts per rod. Provide additional rust proofed structural steel members, where required for proper support. Provide oversized hangers where insulation/supports must pass between pipe and hanger. Hangers, when attached to joists, shall only be placed at the top or bottom chord panel point. Only concentric type hangers are permissible on joists; "C" type not permitted on joists. Provide riser clamps for each riser at each floor.

3.6 PIPE CONNECTIONS

A. Solder Connections: Utilize non-acid flux and clean off excess flux and solder. Flux conforming to ASTM B813 shall be used in conjunction with solder conforming to ASTM B32.

B. Brazed Connections: Make joints with silver brazing alloy in accordance with manufacturer's instructions. Remove working parts of valves before applying heat. "Walseal" fittings may be used; if insufficient alloy is showing, face braze such joints. Filler material shall conform to AWS A5.8

C. Threaded Connections: Clean out tapering threads, made up with pipe dope; screwed until tight connection. Pipe dope must be specific for each application. Threads shall conform to ASTM B.1.20.1.

D. Dielectric Pipe Fittings: Provide Ball valve BV-01 (Refer to specification 230523) where dielectric unions would be required at all equipment connections where dissimilar metals meet. Provide reducers and increasers as required of the same material being connected, each side of the valve. In addition, provide dielectric unions in all open type piping systems (condensing water, domestic water, etc.) where dissimilar metals are to be joined.

3.7 WELDING

A. Welding shall be performed in compliance with the welding procedure specifications prepared by the National Certified Pipe Welding Bureau. Welded piping shall be fabricated by certified welder. Contractor shall submit proof of current certification of each welder, if requested by Owner. Use full length pipe where possible; minimum distance between welds shall be 18 in. on straight runs. Welds must be at least full thickness of pipe with inside smooth and remove cutting beads, slag and excess material at joints; chamfer ends. Minimum gap 1/8 in., maximum 1/4 in., for butt welds. Overlaps on position and bench welds to be not less than 3/4 in. One internal pass and one external pass minimum required on slip-on flanges. Do not apply heat to rectify distorted pipe due to concentrated welding; replace distorted pipe**.** When welding galvanized pipe, apply cold galvanizing on joint after welding.

3.8 HANGER SHIELDS

A. Pre-insulated type or field-insulated type at Contractor's option.

B. Provide for all chilled water and all "non-direct" connection supports.

3.9 SLEEVES

A. Provide for pipes passing through floors, roofs/decks, walls or ceilings.

B. Pre-insulated type: Required for chilled water and refrigerant piping.

C. Standard type: Provide for piping as noted above. Extend 1/8 in. above finished floor in finished areas. In above grade mechanical rooms and other areas with floor drains; use steel pipe sleeves projecting 2 in. above floor. Sleeves shall be as small as practical, consistent with insulation, to preserve fire rating. Fill abandoned sleeves with concrete. Where necessary for pipes to pass through ducts, air chambers or built-up housings and approved by Engineer, provide rubber grommet seals.

D. Roof/deck penetrations: Provide sleeve and deck sealing for watertight installation per detail on Contract Documents.

E. Provide a 0.16 inch thick smooth aluminum jacket over insulated pipes where they pass through sleeves.

3.10 ANCHORS AND GUIDES

A. Provide piping system anchors and guides as shown on the plans, and as recommended by the expansion joint/loop manufacturer. Where an anchor is shown at a change in piping direction, it shall fully control movement in all three axes. In lieu of a single anchor fabricated for two directional pipes, two (2) individual anchors may be provided.

3.11 SLEEVE PACKING

A. Seal void space at sleeves as follows:

B. Interior locations: Firmly pack with fiberglass and caulk.

C. Exterior walls and below grade cored holes: Use sealing element.

D. Fire rated, partitions and floor slabs: Use fire rated sealing elements, materials and methods. Provide per manufacturer's instructions to maintain firestop.

E. Vapor Barriers – provide continuity of vapor barriers through sleeves.

F. Waterproofed floors: Use waterproof sealing element, device, or compound.

3.12 ESCUTCHEON PLATES

A. Provide polished chrome escutcheon plates for exposed piping passing through floors, walls or ceilings, except in Boiler, Fan and Mechanical Rooms.

3.13 CLEANING HOT AND CHILLED WATER SYSTEMS

A. Provide temporary bypasses and/or pumps and pump connections as required to circulate the new piping system or segment without cross contamination of other existing or already cleaned systems.

B. Provide circulating pumps with “startup” fine mesh (1/8” or less) strainer screens during cleaning process.

C. After each closed system has been tested and thoroughly flushed, introduce Sodium Carbonate (one lb. for each 30 gallons).

D. Provide chemical feed tank similar to Calgon #20 Micromet and connect across pump outlet valve, or as called for, with three-valve bypass. Provide temporary meter or other means of determining amount of water in system.

E. Operate pumps and arrange control system so that all control valves are open. Fill, vent and circulate system with this solution, while raising to design temperature.

F. Remove, clean and/or replace air vents, strainers, and check valves, which do not function properly.

G. After cleaning strainers, circulate for additional time, then clean strainers again; repeat until strainers are found clean and system runs visibly clear without any signs of sediment. Drain and refill system.

H. Notify Owner’s Representative before starting Work. Pumps shall not be operated continuously until system is flushed and strainers cleaned.

I. Water Treatment:

1. After system cleaning, furnish report of water test to determine quality.

2. Provide complete water treatment facilities to Owner, including water analysis, feed equipment, metering equipment, pumps, and chemical, obtained from Calgon, Vulcan, Bird Archer, Heating Economy Service, Inc., Mogul, Garratt-Callahan Company, Metropolitan, or Allen-Murray.

3. Recommendations for water treatment shall be reviewed by Owner's Representative before systems are placed into service.

4. Add water treatment as necessary to prevent deterioration of piping system and equipment due to oxygen, acid, scaling.

5. Water treatment shall be deemed complete when circulation has been established throughout, and water runs clear and clean from deposits and discoloration. Submit typewritten letter to inform Owner's Representative upon completion of the Work.

3.14 TESTS

A. Test piping and accessories before insulation, connecting to existing piping, and concealment. Repeat as many times as necessary to prove tight system. Notify Owner's Representative at least seven days in advance of each test. Isolate valves and equipment not capable of withstanding test pressures. Make leaks tight; no caulking permitted. Remove and replace defective fittings, pipe or connections. Furnish necessary pumps, gauges, equipment, piping, valving, power and labor for testing. Certify that test have been successfully completed.

B. Schedule of Test Requirements:

1. Hot, chilled, and domestic water: Hydrostatic, 100 psig at high point of system; two hours duration.

2. Vent, drain, overflow and condensate drain: Hydrostatic, maintain 10 feet head of water above highest point of section being tested for six hours.

3. Refrigeration: Refer to section for Refrigerant Piping and Testing.

4. Tests: No change in pressure under stable temperature conditions.

5. Equipment: Test at working pressures.

3.15 PIPE LINE SIZING

A. Pipe sizes called for shall be maintained. Pipe size changes shall be made only as reviewed by Owner's Representative. Where discrepancy in size occurs, the larger size shall be provided.

EXHIBIT 'A' – PIPING MATERIALS (HVAC)

Notes are at the end of Exhibit 'A'

SERVICE	PIPE MATERIALS	FITTINGS	CONNECTIONS
Hot water heating	Schedule 40, black steel	Malleable iron and butt weld	2 in. and smaller screwed 2-1/2 in. and larger welded SEE NOTE 1
Hot water heating	Type L copper	Wrought copper or cast bronze, solder end	2 in. and smaller: No-lead solder
Chilled water	Schedule 40, black steel	Butt weld and malleable iron	2-1/2 in. and larger welded or flanged 2 in. and smaller screwed SEE NOTE 1
Chilled water	Type L copper	Wrought copper or cast bronze solder end	2 in. and smaller: No-lead solder

Refrigerant	Type L refrigerant grade hard temper, deoxidized copper	Wrought copper, solder end	Sil-Flo "5" silver brazing
Refrigerant	ACR Copper	Wrought copper, solder end	Sil-Flo "5" silver brazing
Vent, Drain, Overflow, Coil Condensate	Schedule 40, galvanized steel or Type M copper	Malleable iron drainage type or wrought copper	Threaded or solder
Coil condensate drain			Socket weld cement
Domestic water	Type L copper	Solder end	2 in. and smaller: No-lead solder

NOTES FOR EXHIBIT "A":

NOTE 1: Screwed piping permitted in Crawl Spaces, Mechanical Rooms and Boiler Rooms.

END OF SECTION 232000

SECTION 232023 - PUMPS

1.0 PART 1 – GENERAL

1.1 DESCRIPTION

A. Provide labor, materials, equipment and services as required, for the complete installation designed in Contract Documents.

1.2 SUBMITTALS

A. Shop drawings and performance curves, on pumps and pump accessories. Clearly indicate which equipment is being submitted.

2.0 PART 2 – PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Pumps shall be non-overloading over their entire performance range with motors capable of running continuously without undue noise, heating, or sparking. Impellers statically and dynamically balanced. Mechanical seals for closed systems, shall be constructed of carbon rings with ceramic mating seat up to 220°F. Packing type seals for open systems only. Materials suitable for water pressures, temperature and conditions for each application. Tapped discharges and suction connections for gauges, vent and drain. With trimmed impeller if required to meet initial delivery requirements. Factory service engineer or machinist must check each pump alignment before pump is started. Include the cost of checking and start-up in pump quotation.

2.2 IN-LINE CENTRIFUGAL PUMPS

A. Designed for continuous operation between 40° and 250°F.

B. In-line, close-coupled, single stage, bronze fitted construction.

C. All pump internals shall be capable of being serviced without disturbing piping connections.

D. Replaceable shaft sleeves at the seal.

E. Enclosed type impeller, keyed to the shaft and secured by a locking cap screw.

F. Factory guaranteed operating performance.

G. Design equipment: Bell & Gossett, Series 80

H. Make: Armstrong, Bell & Gossett, Taco.

2.3 CIRCULATOR PUMPS (WET ROTOR, ECM VARIABLE SPEED)

A. Variable speed, permanent magnet ECM motor.

B. Modified PPE Impellor, stainless steel impellor “can”.

C. Ceramic shaft and bearings

D. EPDM O ring(s)

E. 145psi working pressure @ 230 ºF working temperature.

F. Constant speed, constant pressure, proportional pressure vs flow, temperature control and 0-10vdc input operating modes.

G. Provide with Bacnet communication protocol. Shall be BTL certified.

H. Design Equipment: Bell and Gossett Ecocirc (XL)

I. Make: Armstrong Compass, Grundfoss Alpha / Magna Series, Taco 00e Series

2.4 AUTOMATIC CONDENSATE REMOVAL PUMPS

A. Oil resistant tank and quarter turn check valve. External overflow safety switch and test/run lever. External tank anti-sweat sleeve. 6” plug in power cord. Thermal overload protection.

B. Product shall be provided with 2-year warranty.

C. Design Equipment: Little Giant VCMX-20

3.0 PART 3 - EXECUTION

3.1 INSTALLATION

A. Adjust flow rate (gpm) of each pump to capacity called for on schedule, re-adjust during balancing. Install in-line pumps in locations shown, supported independently of piping, using hangers on both pump flanges.

B. Level base so that pump and pump casing are not strained. Align pumps as directed by the manufacturer. After pumps have been aligned, install dowels to prevent shifting. Fill base with concrete through grouting holes provided in baseplate. Contractor responsible for accurate size of base and exact location of mounting bolts. Contractor responsible for trouble resulting from poor pump alignment. Provide concrete base pad for each base mounted pump.

C. Base mounted end suction pumps shall be provided with inlet suction diffusers. Pipe suction diffuser blow-off (full line size with ball valve) to nearest floor drain. Provide start-up strainers for first 48 hours of operation. Replace after completion of start-up period. Base mounted, double suction type pumps shall have piping arranged so that there is a minimum of eight pipe diameters of straight pipe at the pump suction connections. Where this cannot be maintained due to field conditions, the Contractor shall notify the Engineer immediately, before beginning piping work. Provide inertia bases as called for, determine exact height of bases required for base mounted elbows; shim to match mounting height of base elbow with inlet and outlet of pump. Provide vibration absorber between pump outlet and inlet and base-mounted elbow.

END OF SECTION 232023

SECTION 232133 - WATER SYSTEMS SPECIALTIES

1.0 PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services as required for the complete installation designed in Contract Documents.

1.2 RELATED DOCUMENTS

A. All work under this section is subject to the Contract Documents and this Contractor shall be responsible for and governed by all the requirements therein.

1.3 SUBMITTALS

A. Submit shop drawings on all water system specialties.

1.4 GENERAL REQUIREMENTS

A. Equipment and accessories shall be rated for a minimum of 125 psi wwp, and 250^{o}F temperatures. Manufacturer's written installation procedures shall become a part of these specifications.

B. Provide equipment, piping, valves, fittings, switches, and miscellaneous equipment necessary and required for the complete installation.

2.0 PART 2 – PRODUCTS

2.1 EXPANSION TANK AND ACCESSORIES

A. Shell and Head: Carbon Steel, welded construction.

B. Design Pressure and Temperature: 125 psi at 240°F.

C. Bladder: Replaceable heavy-duty butyl rubber.

D. ASME Section VIII, Div. 1 with U Stamp.

E. Finish: Red oxide prime coat; factory applied.

F. The tank shall be capable of full acceptance of the tank volume when tank is void of air.

G. Provide lifting rings and supports for floor mounting.

H. Design Equipment: Bell & Gossett Series B.

I. Make: Armstrong, Bell & Gossett, Wessels Company, John Wood Company.

2.2 AIR REMOVAL ASSEMBLY

A. Centrifugal type air separator.

B. Shell and Head: Carbon Steel, welded construction (flanged or threaded connections). Grooved if allowed in Specification Section 232000.

C. Design Pressure and Temperature: 125 psi at 350°F.

D. Stainer: Removable Type 304 stainless steel with maximum 3/16"" perforations and 51% free open area.

E. Designed to collect air to an air removal fitting at the top of the separator.

F. Provide bottom blowdown connection to facilitate routine cleaning.

G. ASME Section VIII, Div. 1 with U stamp.

H. Size: Minimum full size of system piping but shall be oversized for a maximum pressure drop 3.0 ft.

I. Design Equipment: Bell & Gossett Rolairtrol

J. Make: Armstrong, Bell & Gossett, Wessels Company, John Wood Company.

2.3 MAKE-UP WATER VALVE

A. Body and Accessories: Lead free brass with built-in strainer and anti-siphon check valve.

B. Connection. Female ¾" threaded.

C. Design: Bell & Gossett No.7

D. Make: Bell & Gossett or equal.

2.4 STRAINERS – HVAC WATER AND GLYCOL SYSTEMS (NON-POTABLE WATER SYSTEMS):

A. Wye Type Strainer:

1. Bronze 2" and Under (Threaded End or Soldered Connections):

a. Strainer shall be suitable for 150 psi @ 350°F WOG (threaded ASTM B16.15) and 150 psi @ 350 °F WOG (soldered ASTM B16.18).

b. Body: Lead free bronze (NSF/ANSI 372, ASTM B584, C87800, C89833).

c. Cap and Plug: Lead free bronze (NSF/ANSI 372, ASTM B584, C87800, C89833).

d. Screen: Type 304 or 316 stainless steel, 20 mesh.

e. Gasket: Metal filled graphite, PTFE, or copper.

f. Threaded blowdown connection.

g. Magnetic Screen Assembly: Plug with magnetic rod or rod with horseshoe magnets and spacers. Magnet material shall be Alnico N0. 5. Provide a quantity of horseshoe magnets as recommended by strainer manufacturer. To be used where called for and at all locations directly upstream of pumps with EC motors.

h. Makes: Mueller Model LF351 (threaded) or Model LF358 (soldered); Keckley Style F7 (threaded) or Style E7 (soldered); Apollo 59LF-000 series (threaded) or 59LF-300 series (soldered).

2. Cast Steel 2 ½" and Larger (Flanged End Connection):

a. Strainer shall be suitable for Class 150, 285 psi @ 100°F WOG (2½" to 12") and 150 psi @ 150 °F WOG (14" and larger) or Class 300, 500 psi @ 150°F WOG (2½" to 12") and 300 psi @ 150 °F WOG (14" and larger).

b. Body and Cover: Lead free cast steel (NSF/ANSI 372, ASTM A216, Grade WCB).

c. Screen: Type 304 stainless steel, 0.062 perforation (2½" to 4") and 0.125 perforations (5" and larger").

d. Gasket: Spiral wound Type 304 stainless steel with graphite filler.

e. Threaded blowdown connection.

f. Makes: Mueller Model 781 (Class 150) or Model 782 (Class 300), Keckley Style SA-7 (Class 150 and Class 300).

2.5 MULTI-PURPOSE VALVE

A. To serve as system balancing device, shutoff valve and soft seat non-slam check valve constructed with linear contoured disc and calibrated adjustment feature. Designed for installation in vertical position.

B. Body: Angle or straight pattern type, cast iron ASTM A126, Class B with bronze seat.

C. Connection Type: Flanged. Grooved if allowed in Specification Section 232000.

D. Disc: Brass with EPDM seat insert (2" – 8" in size) and stainless steel with brass bushing and EPDM insert (10" and 12" in size).

E. Stem and Spring: Stainless steel.

F. Packing: Teflon-Graphite.

G. Readout Valve: Brass with EPT insert, check valve and gasket.

H. Design Pressure and Temperature: 175 psi at 250°F.

I. Maximum pressure drop of 5.0 ft. or less.

J. Design Equipment: Bell & Gossett Model 3DS (straight pattern) or 3D (angle pattern).

K. Make: Armstrong, Bell & Gossett.

2.6 AUTOMATIC AIR VENTS

A. High Capacity Automatic Air Vent:

1. Float type design to remove contained air or non-condensible gases from liquid piping systems with ¾" threaded connections.

2. Body: Cast iron ASTM A126, Class B.

3. Trim: Stainless steel.

4. Valve and valve Seat: Stainless steel and EPDM.

5. Design Pressure and Temperature: 150 psi at 250°F.

6. Make: Sarco Model 13WS, Bell & Gossett Model 107A, Armstrong Model 1-AV.

B. General Purpose Automatic Air Vent:

1. Float type design to remove contained air or non-condensible gases from liquid piping systems with ¾" threaded connections.

2. Body: Brass.

3. Trim: Stainless steel.

4. Valve and Valve Seat: Stainless steel and EPDM.

5. Design Pressure and Temperature: 150 psi at 240°F.

6. Make: Bell & Gossett Model 87, Taco Model 409 or approved equal.

2.14 BYPASS CHEMICAL FEEDER

A. Cast iron quarter turn closure with Buna-N O-ring. Body shall be carbon steel. Designed for temperatures up to 200°F and pressures up to 200 PSI. Fill capacity shall be greater than 5 gallons.

B. Design Equipment: Calgon #20 Micromet

C. Makes: Calgon, JL Wingert Co. or approved equal.

2.15 PUMP AND COIL FLEXIBLE CONNECTORS

A. Bronze Braid and Hose 2" and Under (Soldered End Connection):

1. Hose and Braid Bands: Bronze.

2. End Connections: Copper female soldered ends.

3. Minimum operating pressure of 150 psi at operating temperature of 200°F.

4. Design Equipment: Metraflex Model BBSC.

5. Makes: Metraflex, Mason Industries, Inc., Flex-Hose Co. Inc.

B. Stainless Steel Braid and Hose 2" and Under (Threaded) and 2½ and Larger (Flanged and Grooved Connections):

1. Hose and Braid Bands: Series 300 stainless-steel.

2. End Connections: Carbon steel Class 150 flanged, Sch. 40 carbon steel male threaded or Sch. 40 carbon steel grooved.

3. Minimum operating pressure of 125 psi at operating temperature of 200°F.

4. Design Equipment: Metraflex Model MLPC and RMF (flange to flange), Model GFC (flange to groove), Model GGC (groove to groove), Metraflex Model SSTC (male thread to male thread).

5. Makes: Metraflex, Mason Industries, Inc., Flex-Hose Co. Inc.

2.16 PRESSURE RELIEF VALVE

A. Bronze ¾" to 2" (Threaded End Connection) for Heating Hot Water, Chilled Water and Heating Glycol or Cooling Glycol Systems:

1. ASME Section IV capacity certified for protection of heating hot water systems, pre-set minimum pressure range from 30 psi to 125 psi at 250°F.

2. Body and Cap: Bronze ASTM B584, or cast-iron ASTM A126, Class A/B.

3. Spring: Stainless Steel ASTM A313-631.

4. Seat: Bronze ASTM B584 alloy 84400.

5. Corrosion resistant construction.

6. .High Capacity. Sized to relieve full heating capacity of system protecting. Provide multiple valves as required to meet capacity requirements.

7. Makes: Kunkle Model 537, McDonnel Miller Series 250, Watts Series 174A, Apollo Model RVW60.

2.17 COIL PIPING PACKAGES ("TERMINATION KITS")

A. General

1. Combines various functions, such as coil isolation, dirt protection strainer, union connections, etc., as shown in project coil termination details into a single packaged device(s).

2. Where any specific components are not addressed within this paragraph, they shall comply with related requirements within this Section or Division 23 of the project manual.

3. Where balance valves are incorporated into the piping packages, a separate isolation valve shall be provided. Balance valves shall not be used for isolation duty.

4. Permitted for use on coils with connection sizes from ½" through 2 ½".

5. ASTM B283, B36 Brass body, rated for minimum of 250psig at 200 deg F.

6. Ball valves shall match ball valve construction in specification 230523.

7. Strainers shall match construction in specification section 2.7.

8. Hose Kits shall match construction in specification section 2.5.

9. Balance Valves – Manual Type

a. May be provided as part of the termination kit and shall match balance valve specification information in 230523, or provided separately as specified within section 230523.

B. Basis of Design: Griswold Speedset CPP

C. Make: Nexus, Griswold, Bell and Gossett

3.0 PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Obtain detailed instructions from each manufacturer for proper method of installation.

B. Equipment and systems shall be installed in accordance with manufacturer's installation requirements.

3.2 EXPANSION TANKS

A. For compression tanks pitch connection to heating system 1" in 5 ft. minimum up toward tank. Provide shutoff valve in piping connection to system and 3/4" hose end drain valve on tank. Provide supporting steelwork, hangers, and suspension racks. Provide water make-up connection, site glass, petcocks and tank fitting.

B. For expansion tanks, provide housekeeping pad with length and width greater than 1.2 times the maximum diameter of the tank for floor mounted tanks. Provide supporting steelwork, hangers, and suspension racks for wall or ceiling hung expansion tanks. Provide pitch connection to heating system 1" in 5 ft. minimum up toward system. Provide automatic air vent at high point. Provide shutoff valve in piping connection to system and 3/4" hose end drain valve on tank. Provide water make-up connection to air separator or system piping before pump suction. Air separator or air/dirt separator shall have automatic high capacity air vent.

3.3 CHILLED WATER BUFFER TANK

A. Provide housekeeping pad with length and width greater than 1.2 times the maximum diameter of the tank. Provide bypass piping to isolate tank full size of system piping. Provide isolation valves on inlet tank connection, outlet tank connection and bypass piping. Provide drain valve at tank full size of drain connection. Pipe drain valve to floor drain. Provide full size manual air vent valve at tank air vent connection.

3.4 SYSTEM FILLING

A. After cleaning, fill each system from low point:

1. With pumps off, vent mains, risers, runouts, and units, working consecutively from low to high point in building. Obtain approximately 2 psi at highest point. Obtain proper air cushion in compression tanks.

2. Fill system with a 35% mixture (by weight) of propylene glycol and water. Propylene glycol, Dow Chemical "Dowfrost HD".

3.5 AIR VENTING

A. Provide one of the following vents at points in piping system where air may collect.

1. Manual vent assembly consisting of: 1-1/4" x 6" air collection chamber, 1/2" ball valve in accessible location, install hose connection on valve outlet.

2. Automatic vent with air chamber. Automatic air vents are only allowed in mechanical spaces.

B. Air vents located within the chiller mechanical room shall be routed to the glycol make-up unit.

C. Equipment Vents:

1. When equipment is above mains: Connect runouts or risers to upper quadrant or top of mains. Install vent assembly concealed within enclosure, consisting of 1" diameter by 4" to 6" long air collection chamber with 1/4" soft copper tube to manual valve. Mount securely near bottom of enclosure, but not fastened to enclosure. For individual units such as, radiators, fan convectors and units with return grilles: Provide screwdriver operated manual valve, operated from discharge grille or access door. Drill enclosure and position valve for operating without removing enclosure.

2. When equipment is below mains: Connect piping runouts or risers to bottom or lower quadrant of mains. Vent assembly not required in unit. Provide means of purging and draining each unit if required. Use tees instead of ells at low point of runouts.

3.6 AIR REMOVAL ASSEMBLY

A. Provide supports and provide blowdown with hose end drain valve full size of opening.

B. When utilizing bladder type expansion tanks, provide automatic high capacity air vent valve. Air vents shall be piped, full size, 12" above finish floor. For glycol systems, the vent shall be piped, full size of equipment connection, to the glycol make-up unit.

3.7 MAKE-UP WATER VALVES

A. Provide for each system, with 3/4 in. ball valve, bypass connection and isolation ball valve at inlet and outlet of make-up valve and check valve downstream of bypass valve. Set valves to provide 2 psi at high point of system. Provide pressure gauge assembly.

3.8 STRAINERS

A. Provide where called for. Provide blowdown connection for strainers with valves. Provide valve type as specified in Specification Section 230523. All blowdown valves shall be provided with cap or plug. Open ended valves are not allowed.

3.9 SUCTION DIFFUSERS

A. Provide at inlet to base mounted pump.

B. Pipe suction diffuser blowdown connection (full line size with ball valve) to nearest floor drain.

C. Provide support under suction diffuser. Suction diffuser shall not be supported by the pump casing. If inertia base is provided to support pump, suction diffuser support shall be supported off inertia base.

3.10 PUMP AND COIL FLEXIBLE CONNECTORS

A. Flexible connectors shall be installed in accordance with manufacturer's installation requirements.

B. Where pump discharge or suction size is smaller than system pipe size, provide concentric type reducing flexible connector.

C. Install flexible connectors within manufacturer's parallel offset tolerances. Flexible connectors shall not be subjected to the weight of equipment or piping causing deformation of connector.

3.11 PRESSURE RELIEF VALVES

A. Heating Hot Water, Chilled Water: Pipe discharge, full size of valve outlet connection, to floor drain and place hanger at elbow. Install piping so as not to introduce stress on pressure relief valve body.

B. Heating Glycol or Cooling Glycol Systems: Pipe discharge, full size of valve outlet connection, to glycol make-up unit tank and place hanger at elbow. Install piping so as not to introduce stress on pressure relief valve body.

C. Heat Exchangers: Provide pressure relief valve on heated fluid discharge side of heat exchanger between heat exchanger and isolation valve. The pressure relief valve shall be sized greater than the maximum capacity output of heat exchanger, and not to exceed the maximum working pressure of the heat exchanger or connected piping system, whichever is lower. Pipe discharge, full size of the valve outlet connection, to floor drain and place hanger at elbow. Install piping so as not to introduce stress on pressure relief valve body.

END OF SECTION 232133

SECTION 233000 - SHEETMETAL AND DUCTWORK ACCESSORIES

1.0 PART 1 – GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services required for the complete installation designed in Contract Documents.

1.2 QUALITY ASSURANCE

A. Ductwork shall be fabricated and installed in compliance with latest edition of the following standards:

1. SMACNA Duct Construction Standards - Metal and Flexible Ductwork.

2. SMACNA Duct Liner Application Standard.

3. NFPA Standards, Bulletin 90A, 96, 101.

4. 2020 New York State Mechanical Code

5. Plans and Specifications which exceed the requirements in any of the referenced standards.

B. All sheet metal shall be fabricated and installed by an experienced Contractor specializing in this type of Work.

C. All ductwork shall be maintained to the following cleanliness standards throughout the project:

1. All ductwork is to be shipped to the job site with ends covered in plastic or capped, and fully shrink or poly sheet plastic wrapped. On arrival to the project site, all ductwork shall be manually inspected and anywhere protective plastic or caps that have been damaged shall be cleaned inside and out and re-wrapped prior to storage.

2. Ductwork protective coverings shall be removed only immediately prior to installation.

3. All adhesive labels or part identification markings shall be on the exterior of the ductwork only.

4. Ductwork shall be stored in an area specifically maintained for that purpose which shall remain clean, dry and have minimum exposure to dust.

5. All open ends are to be maintained covered through the progress of construction with self-adhesive poly sheeting.

6. Duct contaminated due to failure to maintain these standards shall be cleaned to the satisfaction of the Owner and Engineer at the cost of this contractor.

1.3 SUBMITTALS

A. Provide a complete shop standard construction manual including construction details for all shop fabricated materials, fittings, and accessories.

B. Provide coordinated sheetmetal shop drawings. Refer to DUCTWORK SHOP DRAWINGS in this specification section for further requirements.

C. Ductwork detail drawings.

D. Exhaust and kitchen hood details.

1.4 DUCTWORK CLASSIFICATION

A. Duct systems are classified and constructed per the SMACNA pressure classification as follows:

1. All ductwork shall be constructed for a minimum pressure class of 2 in. w.g. unless stated otherwise.

2. Supply duct upstream of air terminal units (supply or return) shall be constructed for a minimum pressure class of 3 in. w.g.

3. Exhaust duct between exhaust air valves and exhaust fans shall be constructed for a minimum of 3 in. w.g.

4. Pressure classes above 3 in. w.g. as called for.

1.5 DUCTWORK SHOP DRAWINGS

A. Prepare minimum 1/4 in. scale drawings:

1. Constructed from actual field inspections and measurements so as to assure a complete job.

2. Incorporating dimensions of actual equipment proposed for use on the project.

3. Showing adequate sections, elevations, and plan views and indicating the bottom of ductwork elevations from the finished floor.

4. Indicating all volume dampers, damper access doors, air balance test plugs, and other accessories required for a complete project.

B. Immediately call to the attention of the Engineers any major deviations from the Contract Drawings which must be made. All deviations shall be documented in writing.

C. Submit roof, wall and floor opening dimensions and locations shown on shop drawings.

D. Submit prints to each Contractor of other trades for review for interferences and coordination with their work.

E. Refer to 230010.3.2 for further information related to Sheet Metal Shop and Coordination Drawings

2.0 PART 2 – PRODUCTS

2.1 DUCTWORK MATERIALS

A. Unless otherwise called for, provide materials in accordance with Exhibit I.

2.2 SQUARE AND RECTANGULAR DUCTWORK

A. Transverse and longitudinal duct seams reinforcement shall conform to appropriate tables and figures per SMACNA Pressure Classification for duct construction.

1. “Ductmate" or "Nexus" 4-bolt corner connection systems may be used in lieu of standard construction. Provide all corner brackets, corner bolts, transverse clips, and seals between flange to flange connections

B. Corner closures shall be required as described and illustrated by SMACNA Duct Construction Standards.

C. Throat radius on all elbows shall not be less than dimension of duct in plane of radius. Where this cannot be maintained, use shorter radius with internal guide / splitter vanes per SMACNA guidelines, or square elbow with turning vanes.

D. Bracing and hanging of ductwork shall be per SMACNA Standards for size and pressure class of ductwork being used.

E. Any transformations shall not reduce the ductwork cross-sectional area. Maximum angle in straight duct, 20^{o} for diverging flow and 30^{o} for contraction flow. Transformation from square to round or flat oval seams welded or brazed.

F. Provide 45 degree shoe-taps or 45 degree laterals for square and rectangular branch ductwork. Unless noted otherwise or shown on the contract drawings, 90 degree straight taps or “A” collars are prohibited.

2.3 ROUND AND FLAT-OVAL DUCTWORK

A. Round Ductwork:

1. Manufactured of galvanized steel ASTM A527, gauges per SMACNA Duct Construction Standards, spiral lock-seam or longitudinal fusion-welded, as called for in Exhibit I.

2. All spiral duct shall have locked seams so made as to eliminate leakage under pressure for which this system has been designed.

3. No longitudinal seam duct (“stovepipe”) will be allowed.

4. Round ductwork fittings:

   a. All fittings fabricated Per SMACNA Standards for round and flat-oval ductwork.

   b. Fittings shall have continuous, welded seams.

   c. 90° tees shall be conical type. 90° tees and 45° laterals up to and including 12 in. diameter tap size shall have a radiused entrance into the tap, produced by machine or press forming. The entrance shall be free of any restrictions.

   d. Round taps off the bottom of rectangular ducts down to diffusers shall be made with a 45° square to round shoe-tap.

   e. Spin-in, dovetail, and adjustable take-offs are prohibited unless noted otherwise.

5. Elbows:

   a. Diameters 3" through 12": Two-section stamped and continuously welded elbows.

   b. Over 12": Gored construction with seams continuous welded. Less than 35° - two gores, 36° to 71° - three gores, over 71° - five gores.

   c. Fabricated to a centerline radius of 1.5 times the cross-section diameter.

   d. Adjustable elbows, minimum 26 gauge, maybe used for round duct up to 12" diameter in Velocity-Pressure Classes 2" w.g. and below. Secure and seal adjustable joints air tight after installation.

6. Joints:

   a. Pipe-to-pipe joints in diameters up to 60" shall be by the use of sleeve couplings, reinforced by rolled beads.

   b. Insertion length of sleeve coupling and fitting collar shall be 2" up to 36" diameter and 4" above 36" diameter.

   c. Provide intermediate reinforcing angle rings per SMACNA requirements for pressure class indicated.

   d. Round metallic ducts shall be fastened by a minimum of three sheet metal screws or rivets spaced equally around the joint. Provide sufficient fasteners that duct sections are securely fastened. This requirement does not apply to round duct used for dryer vent.

   e. Clothes dryer exhaust shall be provided in compliance with Section 504 of the MCNYS.

B. Flat-Oval Ductwork:

1. Manufactured of galvanized steel ASTM A527. Within the available sizes, flat-oval duct shall all be spiral wound type ductwork. Gauges per SMACNA Duct Construction Standards.

2. Flat-oval duct shall be adequately reinforced by the installing Contractor to limit the amplitude of wall vibration to ± .008" and the maximum wall deflection to 1/4".

3. Elbows:

a. Gored construction with seams continuously welded. Less than 35° - two gores, 36° to 71° - three gores, over 71° - five gores.

b. Fabricated to a centerline radius of 1.5 times the cross section diameter.

4. Joints:

a. Pipe-to-pipe joints in oval ducts up to 42" the major axis shall be made using sleeve couplings, reinforced by rolled beads.

b. Pipe-to-fitting joints in oval ducts up to 42" major axis shall be made using slip-fit of projecting collar fitting into the pipe.

c. The insertion length of sleeve coupling and fitting collar shall be 2" up to 42" major axis, and 4" above 42" major axis.

d. Pipe-to-pipe and pipe-to-fitting connections for ducts above 42" major axis shall be made by angle ring flanges. Flanges on ducts shall be 1-1/2" x 1-1/2" x 3/16" up to 25" minor axis and 2" x 2" x 3/16" above 25" minor axis.

e. If longitudinal seam duct greater than 42" major axis is supplied in lengths greater than 4 ft., one angle ring must be welded to duct on 4 ft. centers. Welding can be an intermittent weld of 1". in 12".

f. Bolt hole spacing for angle rings shall be 6 in. center.

5. Flat-Oval fittings:

a. Matching flat-oval fittings shall be manufactured from galvanized steel with continuous -welded seams per SMACNA Duct Construction Standards.

b. 90° tees, shoe taps and laterals shall be conical type.

C. Make: Semco, United Sheet Metal.

2.4 DUCTWORK SEALING

A. Ductwork sealing shall comply with paragraphs 403.11 of the ECCCNYS.

B. SMACNA duct sealing classification shall be used for duct systems using the following criteria:

1. Seal Class A, shall include transverse and longitudinal joints and duct wall penetrations, grommets at damper shafts for all ductwork to be provided.

C. Approved ductwork sealing materials shall include the following Hardcast products or approved equivalents when and where applied per manufacturer's recommendations and requirements:

1. Water Based Sealants - Versa-grip 181

D. Tapes and mastics used to seal metallic and flexible air connectors shall comply with UL 181B and be marked 181 B-FX for pressure sensitive tape or 181-B-M for mastic.

2.5 TURNING VANES

A. Standard Type:

1. Provided in square elbows as shown on contract drawings. Vanes for ducts with areas greater than 100 sq. in. shall be "double" type having dimensions and spacing as detailed.

2. Make: Elgen, or contractor fabricated.

2.6 DAMPERS IN DUCTWORK

A. Volume Dampers:

1. Provide single blade type volume dampers where duct sizes in both dimensions are under 12". Constructed per SMACNA standards, one gauge heavier than duct material. For round ducts, Rossi RD series blades securely fastened to 3/8 in. sq., cold rolled steel operator rod and B300/B330 end bushings. For rectangular ducts use Greenheck MBD-10M with 3/8 in. sq., cold rolled steel operator rod. Provide quadrant locking handle on standoff for ductwork to be externally insulated. Wing nut friction screw type are specifically prohibited. Shop fabricated or alternate damper manufacturers meeting these specifications are to be submitted for approval.

2. Provide volume dampers at all air outlets, diffusers, grilles. Dampers to be located at branch takeoff collar or as close as practical. Use of register dampers in return or exhaust inlets shall be strictly limited and approved by the Engineer in advance.

3. Provide multi-blade dampers above 12 in. duct dimension in width or depth. Where multi-blade dampers are required, they shall be equal to Ruskin Model CD35. Provide quadrant locking handle on air volume dampers, wing nut friction screw type are specifically prohibited. Provide quadrant locking handle on standoff for ductwork to be externally insulated.

B. Fire and Smoke Dampers:

1. See "Fire and Smoke Dampers" Section 233316.

C. Automatic Air Dampers:

1. Furnished as part of "Control Systems" Section 230923 installed by this Contractor.

2.7 FLEXIBLE DUCTWORK

A. Shall be constructed in compliance with NFPA Bulletin 90A, and UL Standard 181, Class I Air Duct:

1. Consisting of corrosion resistant galvanized steel helix mechanically locked to fabric. Fabric to be a trilaminate of aluminum foil, fiberglass and aluminized polyester.

2. Factory applied, fiberglass exterior insulation, sheathed in a seamless reinforced exterior vapor barrier jacket. Refer to Specification 230700 Insulation for required R-Value and insulation thickness.

3. Flexible ductwork shall be rated for 20" w.g. positive pressure, 10" w.g. negative pressure thru 12" dia.; 5" w.g. negative pressure, 14-16" dia.; 1" w.g. negative pressure 18"-20" dia., 5500 fpm, operating temperature range -20°F to 250°F.

B. Design Equipment: Flexmaster Type 3B (insulated), Flexmaster Type N1-35 (uninsulated).

C. Make: Clevaflex, Flexmaster, Genflex, Thermaflex.

2.8 FLEXIBLE CONNECTIONS TO FANS AND EQUIPMENT

A. Materials for flexible connections shall be fire retardant, water and mildew resistant, and comply with UL Standard 214:

1. Systems up to 2" w.g. s.p.: approximately 20 oz. of fabric per sq. yd. Ventfabrics, Inc., "Ventfab".

2. Systems greater than 2" w.g. s.p., and watertight systems: Of heavy glass fabric, double neoprene coated, approximately 30 oz. per sq. yd. Ventfabrics Inc., "Ventglas".

3. Flexible connections for grease duct system fans shall be listed and labeled for the application per NYSMC 506.3.2.4

2.9 ACCESS DOORS

A. In Ductwork: Shall be double panel construction, 1" rigid insulation when in insulated ducts; SMACNA construction, hinged type. Double cam type only acceptable where hinged type will not fit and if approved by engineer. Same metal as duct, or factory fabricated. Doors airtight to fit system static pressure, minimum size 16" x 12" or as practical based on the specified location. Refer to section 233316, "Fire and Smoke Dampers", for additional requirements.

B. When installed in intake or exhaust plenums, access doors will be sized to allow for full access to plenum.

C. Where plenums are greater than 4 feet wide or deep, the access door is to be at least 2 ft. wide by 4 ft. tall to allow for personnel entry.

D. Door Hardware:

1. Hinges: Minimum of two per door, at least 1-1/2" long by 1/8" thick, spaced no more than 2 ft. apart and no more than 1/4 of the door size from top to bottom of door. Maximum 4" length, 6 ft. door, for larger doors, length equal to 1/12 door height.

2. Latches: As manufactured by Ventfabrics, Inc. or equivalent. Metal window sash latch not acceptable.

a. Access doors up to 2" w.g.: Ventlok #100/#102.

b. Walk-in doors up to 2" w.g.: Ventlok #260.

c. Access or walk-in above 2" w.g.: Ventlok #310.

E. Make: Air Balance, Ruskin, Ventlok, Elgen.

2.10 ACOUSTIC-THERMAL DUCT LINING IN DUCTWORK

A. Duct Liner (Fiberglass):

1. General: Comply with NFPA Standard 90 and NAIMA Standard AHC-101.

2. Materials: ASTM C 1071, Type I. Acrylic coated glass fiber insulation coated with an anti-microbial EPA registered coating that seals the airstream surface fibers into a smooth, low-friction surface acoustic ductliner shall be of thickness shown in the table. Maximum "K" value to be 0.16 btu/in./sq. ft./degrees F./hr. when tested in accordance to ASTM C518. Absolute roughness per foot not to exceed 0.004 ft. Acoustic duct liner to be suitable for use up to 6000 feet per minute air velocity and temperatures up to 250 degrees F. The acoustic duct liner shall not contribute to the corrosion of steel, copper or aluminum. The liner shall not absorb greater than 0.5% moisture by volume when exposed to air of 120 degrees F., 96% RH. Acoustic duct liner shall provide the minimum sound absorption coefficients shown below when tested per ASTM C423-90 and ASTM E795, Mounting Type A.

OCTAVE BAND FREQUENCIES HZ							
Thickness	125	250	500	1000	2000	4000	NRC
1-1/2 in.	.16	.51	.90	1.05	1.06	1.01	.90
2 in.	.23	.73	1.05	1.13	1.06	1.07	1.00

3. Thickness: Refer to section 230700 for ductwork insulation requirements. Where insulation is provided solely for acoustic purposes, minimum insulation thickness shall be 1 ½ inches.

4. Fire Hazard Classification: Flame spread rating of not more than 25 without evidence of continued progressive combustion and a smoke developed rating of no higher than 50, when tested in accordance with ASTM E84 and UL 723.

5. Liner Adhesive: Comply with NFPA Standard 90A and ASTM C916.

6. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct. Provide fasteners that do not damage the liner when applied as recommended by the manufacturer, that do not cause leakage in the duct, and will indefinitely sustain a 50 pound tensile dead load test perpendicular to the duct wall.

7. Fastener Pin Length: As required for thickness of insulation, and without projecting more than 1/8 inch into the airstream.

8. Adhesive for attachment of mechanical fasteners: Comply with the "Fire Hazard Classification" of duct liner system.

9. <u>All ductwork that is lined shall be provided with double wall. Refer to "DOUBLE WALL DUCTWORK".</u>

2.11 <u>DOUBLE WALL DUCTWORK</u>

A. Refer to separate requirements for grease duct systems.

B. Rectangular duct and fittings shall be of Pittsburgh-lock longitudinal seam construction with TDC transverse duct connectors conforming with the latest edition of the SMACNA Duct Construction Standards, Metal and Flexible.

C. Double wall round and flat oval connections shall be performed using slip couplings with sealant and screws up to 36 inch diameter, flanged over 36", joined in a manner meeting all manufacturer's requirements.

D. Duct shall be of a minimum G90 galvanized steel (ASTMA653 and A924), uncoated steel (ASTMA366), stainless steel (ASTMA167 and A480) or aluminum (ASTM B209) as called for.

E. Square throat elbows and tees shall be provided with factory installed double wall turning vanes in accordance with SMACNA recommendations.

F. Insulation shall be fiberglass meeting the values specified within section 230700 unless specifically noted to the contrary on the project drawings.

G. The inner liner shall be perforated to an overall open area of approximately 23 percent. Solid liners shall be provided where noted on the project drawings.

2.12 INSTRUMENT TEST HOLES

A. Suitable for insertion pitot tubes and other test instruments:

B. Fabricated with heavy screw cap and gasket.

C. With sufficient extension to accommodate exterior insulation where required.

D. Make: Ventlok #699.

3.0 PART 3 – EXECUTION

3.1 REQUIREMENTS

A. Equipment and systems shall be installed in accordance with local and state codes and regulations having jurisdiction.

B. Install all ductwork concealed and tight to the structure above unless noted otherwise on shop drawings. Fabricate only after the approval of shop drawings, and in locations to avoid interference. Ductwork installed without approved shop drawings, which requires removal/modification and/or reinstallation due to conflicts or improper installation shall be corrected at no cost to the Owner.

C. Sizes given on contract drawings are inside dimensions. Keep openings closed with protective caps or blanks during construction to prevent entrance of dirt and debris.

D. Extend access openings, damper rods and levers, to outside of external insulation make systems airtight.

E. No piping, conduit or other obstruction to airflow is permitted in ductwork. Where shown on the drawings or permitted through approved shop drawings, provide with airtight streamlined sleeve, soldered or brazed joint between sleeve and ductwork. Increase size of ductwork to maintain proper cross-sectional area.

F. Provide necessary openings, sleeves, hanger inserts, framing, chases, and recesses, not provided by other trades.

G. Exposed exhaust or return registers and grilles shall be flush with face of duct; exposed supply registers and grilles shall be mounted outside airstream with 45^{o} shoe-tap extension collars.

H. Provide sleeves for ducts passing through walls or floors. Use 14 gauge sleeve with framing through structural surfaces; 18 gauge sheet metal for other cases. Set sleeves 4” above finished floor in Mechanical Rooms, seal watertight to floor.

3.2 FLEXIBLE CONNECTIONS

A. Provide flexible connections for the intake and discharge connections of duct connected to fans and air handling equipment:

1. Round connections made with adhesive and metal drawbands with ends tightly bolted.

2. Rectangular connections made with material securely held in grooved seam between flanges, tightly clipped or riveted on 6" centers.

B. Connections made with a minimum of 2" space between duct and equipment collars, installed in line, and with 1" excess material folded so as not to interfere with airflow through connection.

3.3 FLEXIBLE DUCTWORK

A. Install flexible duct systems, including connections and joints, in accordance with manufacturer's installation instructions, ADC Flexible Duct Performance and Installation Standards Chapter 4 "Installation Requirements", and with UL 181, Class 1 Air Duct.

B. Flexible ductwork shall not pass through any wall, floor or ceiling.

C. Duct slide on depth minimum of 2" and secured with ½" stainless steel worm gear clamp or non-metallic band clamp meeting UL 181B-C. Connections to conform with all manufacturer's requirements. Maintain insulation value and vapor barrier without gaps from branch main to diffuser / grille / register connection.

D. For round-to-oval connections, provide round-oval flexible adapter.

E. Maximum length 48", not to penetrate any wall, ceiling or floor.

F. Maximum one 90^{o} angle wide radius bend from ductwork to outlet. Provide molded flexible elbow support secured to structure to support bend radius. Thermaflex flexflow or approved equal. Use of Panduit straps unapproved means of bend support are specifically prohibited. Where a wide radius cannot be maintained, provide hard duct elbow at outlet.

3.4 TURNING VANES

A. Install fixed turning vanes in square elbows of equal dimensions only.

1. Provide turning vanes in compliance with SMACNA duct construction standards figures 2.3 and 2.4

2. Use large size vanes, 2-1/4" spacing when ducts are 20" or wider.

3. Secure vane runners to duct with spot welding, riveting or sheet metal screws.

4. Seal all penetrations for attachment of vane runners.

B. For unequal dimension elbows:

1. Provide Aero Dyne HEP turning vanes and rail assembly or approved equal

2. Turning valves to be installed in compliance with all manufacturer requirements to obtain intended performance.

3. Adjust vanes for angle of attack per manufacturer instructions

4. Seal all penetrations for attachment of vane runners.

C. When installing in ductwork with internal insulation:

1. Install runners in ductwork inside insulation and bolt through insulation and duct sides, welding bolts to insure rigid installation. Provide build-outs for duct Velocity-Pressure classes above 2" w.g.

3.5 INSTRUMENT TEST HOLES

A. Locate in the following locations:

1. Downstream of fan discharge

2. Downstream of fume hood

3. Downstream of exhaust duct

4. Downstream of fan inlet.

3.6 CLEANING DUCTWORK AFTER INSTALLATION

A. Clean rubbish and dirt from system before fans are turned on.

B. Keep openings closed during this construction period.

C. Pay damages resulting from dirt blown on painted or other finished surfaces.

D. Repair or replace damaged fan wheels, dampers, or other system parts damaged as a result of dirt.

E. Clean system as many times as required until the entire system is dirt-free.

3.7 INSTALLATION ROUND AND FLAT-OVAL DUCTWORK

A. Use factory fabricated couplings for joints.

B. After the joint is slipped together, sheet metal screws are placed ½" from the joint bead for mechanical strength.

C. Sealer is applied to the outside of the joint and covering the screw heads.

D. Flanged joints shall be made with neoprene rubber gaskets.

3.8 LEAKAGE TEST OF DUCTWORK

A. Where indicated on the drawings or these specifications, and for ALL duct systems designed to operate at 3" wc or higher, conduct duct leakage tests per SMACNA "HVAC Air Duct Leakage Test Manual", latest edition.

1. Documentation shall be furnished to the Engineer demonstrating that representative sections totaling lot less than 25% of the duct area have been tested and all sections are in compliance with this section.

2. Ductwork shall be shown to have a rate of air leakage (CL) less than 4.0 as determined in accordance with equation 4-8, paragraph C403.11.2.3 of the ECCCNYS

B. Ductwork designated to operate below 3" wc shall be checked and guaranteed to meet standards of SMACNA Seal and Leakage Classifications, seal Class A. Air balancing and testing shall be used to determine satisfactory operation of duct systems.

C. When leakage above stated limits occurs, ascertain location of leaks and repair as required. Repeat tests as required to document allowable leakage rates have been achieved. Prepare a report similar to that suggested by SMACNA and submit for review. Duct testing shall be conducted in the presence of the Owner's Representative.

3.9 DAMPERS AND AIR CONTROL DEVICES

A. Provide dampers necessary to permit proper balancing of air quantities. Comply with code requirements for smoke and fire control. Prevent introduction of uncontrolled outside air into building through roof and wall openings.

B. When dampers are installed in acoustically lined ductwork, install with insulated "build-outs" per SMACNA.

C. Install fire and smoke dampers in accordance with "Fire and Smoke Dampers" Section and applicable codes.

D. Install all dampers furnished as part of "Control Systems" Section.

3.10 ACCESS DOORS

A. Provide as required for maintenance and service access at:

1. Control dampers

2. Damper motors

3. Smoke, fire and combination smoke / fire dampers for inspection and services as required under NFPA 80 and NFPA 105.

4. Smoke detectors

5. Control instruments

6. Fan bearings

7. Both inlet and outlet of terminal heating and/or cooling coils

8. Intake or exhaust plenums

9. Any other equipment requiring periodic inspection or service, complete with angle iron frame.

10. Duct mounted heating/cooling coils

3.11 DUCT SUPPORTS

A. Provide per SMACNA, same material as duct. Hanger bands to extend down sides and turn under bottom 2". Minimum two metal screws per hanger. Steel angle or "unistrut" on larger duct. Spaced per building structural system but not greater than 8 ft or the maximum allowable by SMACNA guidelines. Provide extra support angles as required.

B. Provide supports per manufacturers requirements for factory fabricated duct systems

C. Refer to section 230550 for wind restraint of exterior ductwork systems.

3.12 AIR AND WATERTIGHT METAL WORK

A. Where water or snow may accumulate and ductwork or where odors or corrosive gasses may collect, ductwork and plenums shall be made watertight by soldering, brazing or welding of joints. Grade ducts down toward waste points and/or toward louvers. Provide valve and drain piping from low point to waste point. The following ductwork shall be constructed air and watertight:

1. Intake and exhaust plenums.

2. Dryer exhaust ductwork.

B. Test for water-tightness: Before concealment, apply water by hose to check for leaks, witnessed by Owner's Representative.

C. Where ductwork is sufficiently large to allow personnel access, light testing similar to that required for grease duct may be used in lieu of water hose testing prior to installation of any exterior insulation systems.

3.13 ACOUSTIC-THERMAL DUCT LINING

A. Duct area on project drawings are clear areas. Increase metal duct dimensions to accommodate lining.

B. Adhere lining to interior side of duct; minimum 90% coverage of Benjamin Foster 85-20 fire retardant adhesive, UL approved. Stapling method of attaching will not be permitted. Mechanical fasteners shall not pierce the sheet metal. Installing fasteners with spacing as per SMACNA Standards. Multiple layers of liner to achieve indicated thickness is prohibited.

C. Butting edges of acoustic linings shall be sealed with a fire-resistant neoprene coating, and exposed edges of acoustic linings shall be installed with sheet metal nosing to prevent erosion.

D. Lining shall not impart odor to the air, delaminate or be loosened by the airstream under normal operating conditions. Lining which is damaged during fabrication or shipment shall not be installed.

E. Linings shall be interrupted at the area of operation of a fire damper and at not less than 6 inches upstream and downstream of electric-resistance and fuel burning heaters in duct systems.

F. Metal nosings or sleeves shall be installed over exposed duct liner edges that face the opposite direction of the air flow.

G. Where a duct liner has been interrupted, a duct covering of equal thermal performance shall be installed.

H. Thermal acoustic duct liner shall not be used to line ducts or plenums from the exit of a cooling coil to the downstream end of the drain pan.

3.14 DOUBLE WALL DUCTWORK SYSTEMS

A. Duct dimensions shown on project drawings are clear inside dimensions.

B. All ductwork is to be installed in strict compliance with the Mechanical Code of the State of New York, SMACNA guidelines and manufacturer’s requirements.

C. Where insulation values of the ductwork do not meet the requirements stated in section 230700, exterior ductwork insulation shall be provided to meet those requirements.

E. Insulation values shall be maintained at all transitions between duct systems and types. Insulation ends shall be provided at all locations where internally insulated double wall duct connects to single wall duct or any non-insulated component. The insulation end shall terminate the insulation and reduce the outer shell diameter to the nominal single wall size.

3.15 SMOKE DETECTION

A. Smoke detectors shall be furnished by Division 26 "Electrical". This Contractor shall install detectors located in ductwork. Clearly indicate locations of smoke detectors on the sheet metal shop drawings.

B. Increase duct size at smoke detectors, where required for proper installation, per smoke detector manufacturer's recommendations. Coordinate minimum duct size required with Division 26 "Electrical".

EXHIBIT I - DUCTWORK MATERIALS
(Notes are at the end of Exhibit "I")

SERVICE	MATERIAL	SPECIAL REQUIREMENTS
Supply, return, vent, relief, and exhaust	Lock forming quality, galvanized steel ASTM 525	Joints and features as called for SEE NOTE 1
Accessories, dampers and air turns	Same or better as parent duct	------
Field constructed apparatus casings	Galvanized steel ASTM 525	

NOTES FOR EXHIBIT I:

NOTE 1: Supply ductwork downstream of air terminal units shall be acoustically lined for a minimum of 8 ft.

END OF SECTION 233000

SECTION 233316 - FIRE AND SMOKE DAMPERS

1.0 PART 1 – GENERAL

1.1 DESCRIPTION

A. Provide labor, materials, equipment and services as required for the complete installation as shown on the Contract Documents.

1.2 SUBMITTALS

A. Types, schedule of sizes, locations, and installation arrangements of all dampers.

B. Manufacturers UL listed installation details for each mounting arrangement.

C. Installation certification per paragraph 3.3 of this section.

D. Identification chart for dampers per paragraph 3.4 of this section.

E. Size, location and construction detail of all fire rated access doors.

1.3 QUALIFICATIONS

A. Provide work in accordance with latest requirements of the New York State Building Code, NFPA 90A, NFPA 101 and UL 555 (Seventh Edition), UL 555S (Fifth Edition). Fire dampers shall be Underwriter's Laboratories classified.

B. All Dampers shall be rated for protection at 350°F and shall be Leakage Class I.

C. Smoke dampers and operator assemblies shall be Underwriter's Laboratories classified as an assembly.

D. All fire rated access doors shall be in accordance with NFPA 80 and 104.

2.0 PART 2 – PRODUCTS

2.1 FIRE DAMPERS

A. Rectangular - Curtain type damper of galvanized construction with fusible link, roll formed frame and stainless steel closure spring. UL listed and labeled.

B. Round – 20 gauge galvanized steel sleeve / frame, with 14 gauge galvanized blades. Stainless steel bearings pressed into frame. UL listed and labeled.

C. Dampers are to be selected for no more than 0.1”wc pressure drop in the as-installed conditions, but in no case shall be smaller than the ductwork size stated on the project drawings. Provide necessary duct transitions, sleeves and supports to maintain assembly rating and these free area requirements.

D. Provide duct transitions where duct sizes must be increased to maintain maximum allowable pressure drop or for transition between round / oval / rectangular ductwork systems.

E. 1-1/2 hour rated dampers for assemblies with rating under three hours. Three-hour rated dampers for assemblies with rating of 3 hours or greater.

F. Provide with "break away" duct connections which comply with rated assembly construction details.

G. Fusible link temperature rating of 165°F

H. Type B or C as called for on the contract drawings or as required to meet installed pressure drop and performance requirements.

I. Stainless steel or all aluminum construction where required based on application.

J. Design Equipment:

1. Rectangular:

a. Static, 1 ½ hour, Ruskin Model IBD2

b. Static, 3 hour, Ruskin Model IBD23

c. Dynamic, 1 ½ hour, up to 4000fpm and 4"wc, Ruskin DIBD2

d. Dynamic, 3 hour, up to 4000fpm and 4"wc, Ruskin DIBD23

2. Round – Ruskin FDR25, Static or Dynamic up to 2000fpm.

B. Make: Air Balance, Greenheck, National Controlled Air, Prefco, Ruskin, Safe Air, Inc., Venco.

2.2 COMBINATION FIRE/SMOKE DAMPERS

A. Rectangular - Airfoil multi-blade type damper of aluminum construction suitable for installation in high velocity air systems up to 4000 fpm and 8 in. s.p. UL listed fusible link. Frame thickness 16 gauge minimum. Silicone edge blade seals, and stainless steel jamb seals.

B. Round – two piece, 14ga equivalent galvanized steel blades. Stainless steel bearings pressed into frame. Suitable for installation in systems up to 3000fpm and 4 in. s.p. UL listed fusible link. 20 ga frame / sleeve.

C. UL listed 120 volt electric motor operator as scheduled or called out on the contract drawings. Operator to be mounted outside of the airstream. Power to open spring to close.

D. Class I leak rating of 4.0 cfm/ft^2 at 1" w.g.

E. Stainless steel or all aluminum construction where required based on application.

F. Design Equipment:

1. Rectangular: Ruskin FSD-60.

2. Round: Ruskin FSDR-25

G. Make: Greenheck, Air Balance, Prefco, Ruskin.

2.5 FIRE RATED ACCESS DOORS

A. Fire rated access doors shall be designed specifically for application rated wall openings and shall bear an Underwriters' Laboratories fire door label for a two or three-hour rating to match adjacent construction.

B. Design Equipment:

1. Two hour rated for walls – Activar FD Series

2. Three hour rated for walls – Activar FD3 Series

C. Make: Air Balance, Duro, Prefco, Cesco.

3.0 PART 3 – EXECUTION

3.1 LOCATIONS

A. Provide where called for on the contract drawings and as required per Section 607 of the New York State Mechanical Code.

3.2 INSTALLATION

A. Provide sleeves, angles, and access doors for installation in accordance requirements of NFPA, UL and damper manufacturer. Provide sheet metal access doors in ductwork for dampers and accessories. Provide ceiling or wall access doors for dampers and accessories. Provide rated access doors where required in shafts and other rated assemblies.

B. All fire, smoke and combination dampers to be selected and fully coordinated with access requirements, including required service access and inspection doors. Final selection details, including upstream vs downstream positioning of access doors and damper actuators shall be determined during development of project coordination drawings as described under 230010.3.2.

C. Division 26 "Electric" will provide signal wiring and power wiring for smoke dampers. Refer to Sections 230923 and / or 230993 for additional requirements. Smoke detectors shall be furnished by Division 26 "Electric". Install detectors located in ductwork. Increase duct size at smoke detectors, where required for proper installation, per smoke detector manufacturer's recommendations. Coordinate minimum duct size and length required with Division 26 "Electric". Provide insulation end seal fittings for double wall ductwork where same connects to damper assembly.

D. Fire doors in fire wall openings and shall be installed on both sides of a fire wall. Install in accordance with UL and the manufacturer's instructions. Provide thermal blanket in accordance to NFPA requirements at diffusers, register and grille penetrations of fire rated ceilings where fire dampers are required.

E. Provide access door or removable ductwork section for inspection and repair in compliance with NFPA 80 and NFPA 104 for all assemblies. Minimum allowable access door size shall be 12”x12”, minimum allowable length for removable duct section shall be 24 inches.

3.3 CERTIFICATION

A. Contractor shall certify that dampers are accessible for servicing, are installed properly, and are operational. Submit three copies of signed certification to the Owner's Representative for review.

3.4 IDENTIFICATION

A. Provide damper tags and chart. Fasten tag to ductwork adjacent to the dampers. Number each damper and make chart listing.

1. Number

2. Location

3. Air system in which they are installed.

B. Submit three copies of chart to the Owner's Representative for review.

END OF SECTION 233316

SECTION 233400 - FANS

1.0 PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide labor, materials, equipment and services as required for the complete installation designed in Contract Drawings.

1.2 SUBMITTALS

A. Submittals shall include all fans, motors, drives, and accessories. Include all fan curves and fan operating point.

1.3 QUALITY ASSURANCE

A. Capacity, size and arrangement, static pressure, brake horsepower, component parts and accessories shall be provided as called for or scheduled. All ratings shall be made in accordance with AMCA Standard 210. Guaranteed full capacity delivery through duct systems finally installed and under conditions listed. The manufacturer shall guarantee sound-power level ratings not exceeding those of the design equipment. All equipment shall be statically and dynamically balanced to acceptable tolerances with weights permanently fastened. Fan wheels shall be rebalanced in the field, if necessary.

B. Fans shall be selected such that the rotational speed does not exceed 80% of that allowable for the fan class to be provided.

C. Motors:

1. Motors shall be furnished with each fan of sizes scheduled. Refer to specification Section 230513 for acceptable motor manufacturers. All belt-driven fan motors shall be mounted on either an adjustable slide base or a pivoting base.

2. Fans specified either through model number or motor type to contain ECM motors shall be provided with either local speed adjustment modules or controllers allowing interface to the BMS as required for specified sequences of operation.

D. Drive Systems:

1. Provide fans with belt or direct drive systems as scheduled. V-belt drives as recommended by drive manufacturer, unless otherwise specified or scheduled.

a. Below 10 hp: Size 150% of motor rating.

b. 10hp & up: Size drive for 200% of motor rating.

c. Motors 5 hp and larger shall be provided with a minimum of two matched belts. All belt sets shall be matched.

d. Cast iron or cast steel pulleys.

e. Provide a belt and shaft guards for each driven device. Provide openings in both the motor and fan sections of the guard so that the motor and fan speeds can be checked without removing the belt guard.

f. For belt driven devices, provide factory installed automatic belt tensioner to maintain proper belt tension.

E. Motor Pulleys:

1. Adjustable type to produce 15% speed change above and below scheduled fan speed permitted for 5 hp and smaller.

2. Fixed drive pulleys for all motors over 5 hp. Provide replacement pulleys as required to obtain system balance.

3. 7-1/2 hp - 20 hp: "B" section, 4.6 in. minimum pitch diameter.

4. 25 hp & larger: "C" section, 7.0 in. minimum pitch diameter.

5. Drive ratio not over 4:1.

6. Vibration isolation for units shall be furnished by fan manufacturer unless otherwise noted. Where spring vibration isolators are used, they shall be guided spring type.

2.0 PART 2 - PRODUCTS

2.1 CENTRIFUGAL FANS

A. All fan wheels shall be aluminum, backwardly curved of a non-overloading blade design. Blades, double thickness airfoil design, single thickness airfoil design. Bearings mounting adjustable and self-aligning, 50,000 B-10 life hours rated in accordance with AFBMA. Equipped with overflow pipe and overflow reservoirs. Factory mounted and wired disconnect switch.

B. Direct drive fans shall be provide with ECM Motor. Variable volume fans shall be provided to accept a 0-10V DDC command. Constant volume fans shall be provided with built in fan speed adjustment.

C. On belt driven units, motor and adjustable drive isolated from airstream. Permanently lubricated motor bearings. Fan motor shall be VFD rated were noted for use with VFD.

D. Supply fan configurations shall be provided with factory filter box with MERV 8 filters.

E. Design Equipment: Greenheck BSQ/SQ-VG Series.

F. Acceptable Make: Cook, Greenheck, Twin City.

3.0 PART 3 - EXECUTION

3.1 INSTALLATION OF EQUIPMENT

A. Provide equipment in accordance with manufacturer's instructions. All fans shall meet the intent of the system performance requirements. Provide rubber in-shear vibration isolation for all fans unless otherwise called for differently. Provide necessary supporting ironwork and platforms for equipment as detailed on the contract drawings. Provide guards for all exposed belts, shafts and fan wheels. Change pulley sizes or adjust sheaves as required to make systems deliver specified quantities of air as listed on the Contract Drawings.

B. Provide fan control equipment as specified or scheduled on the Contract Drawings. Coordinate location of fan control equipment with all contractors.

END OF SECTION 233400

SECTION 233713 - REGISTERS AND DIFFUSERS

1.0 PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services required for the complete installation designed in Contract Documents.

1.2 SUBMITTALS

A. Registers/Grilles/Diffusers. Submit room schedule listing size, throw, direction of throw, accessories, finish, noise criteria levels, material type and color chart.

1.3 GENERAL REQUIREMENTS

A. Each manufacturer shall check noise level ratings for registers and diffusers to insure that the sizes selected will not produce noise to exceed 30 db, "A" scale, measured at occupant level; notify Owner's Representative of problems prior to shop drawing submittal.

B. Pressure drop, air flow and noise criteria selection are based on design equipment. Manufacturers not submitting design equipment must provide written certification in the front of submittal that equipment submitted has been checked against and performs equal to the design equipment.

1.4 REQUIREMENTS FOR REGISTERS

A. General:

1. A register is defined as a grille plus a volume damper.

2. Registers shall be installed "sight-proof" where possible, i.e., high wall register with horizontal blades inclined up, or along a wall with blades facing the wall.

3. Borders and frames shall be of same material as register face unless specified otherwise.

4. Maximum N.C. permitted shall be 25. Registers exceeding this value shall be increased to reduce N.C. Level below 25.

5. All RGD plenums interiors shall be painted flat black.

B. Mounting Frames:

1. Provide with screw holes in register face punched and countersunk at factory, and mounting frame drilled and tapped to suit. Sponge rubber gasket between frame and wall or ceiling for all surface mounted frames.

2. Frame shall be overlap type and shall be suitable for type of ceiling where register is to be installed.

C. Finishes:

1. Custom color/finish to be selected by the architect during the submittal process.

D. Design Equipment: Krueger unless otherwise noted.

E. Make: Krueger, Titus, Price

1.5 REQUIREMENTS FOR DIFFUSERS

A. General:

1. Provide four way blow unless otherwise noted.

2. Where manufacturer's size recommendations require duct sizes or connections differing from design Contractor shall provide at no change in Contract price.

3. Provide square to round neck transitions as required.

4. Provide sponge rubber gasket for all surface mounted frames.

5. Maximum N.C. permitted shall be 25. Registers exceeding this value shall be increased to reduce N.C. Level below 25.

6. All RGD plenums interiors shall be painted flat black.

B. Finishes:

1. Custom color/finish to be selected by the architect during the submittal process.

C. Design Equipment: Krueger unless otherwise noted.

D. Make: Krueger, Titus, Price

2.0 PART 2 - PRODUCTS

2.1 REGISTER TYPES

A. Type A - (exhaust and return grille):

1. Steel construction with 22 gauge frame and blades, with horizontal bars on a 1/2" spacing set at 35^{o} fixed deflection.

2. 1-1/4” wide flange.

3. Provide with 12” square backbox equal to the diffuser neck dimensions.

4. The blades shall be parallel to long dimension.

5. Model: Krueger S85

B. Type B - (Steel exhaust and return grilles):

1. Steel construction with 22ga frame and blades, with horizontal bars on a 3/4" spacing set at 35° fixed deflection.

2. Key operated opposed blade damper.

3. 1-1/4” wide flange.

4. Provide with 12” square backbox equal to the diffuser neck dimensions.

5. The blades shall be parallel to long dimension.

6. Model: Krueger S80

2.2 DIFFUSER TYPES

A. Type 1 - (induction nozzle type):

1. 22 gauge steel construction, with face panel finished flush with ceiling system. With optional directional air flow pattern controllers that are concealed behind the face.

2. Core shall be removable and securely held in place to the back pan without noise or vibration.

3. Horizontal air flow pattern.

4. With equalizing grid.

5. Induction nozzles welded to each wing of the inner core. Nozzles shall be oriented at 45 degree angles in split opposite directions.

6. Panel size: 24" x 24", with square inlet as integral part of assembly. Provide with transition piece for attachment of duct dimensions as noted on plans.

7. Provide with 12” square backbox equal to the diffuser neck dimensions.

8. Model: Krueger SHV.

B. Type 2 - (supply register type):

1. Steel 22 gauge frame construction with double deflection capability and the front blades shall be parallel to the long dimension. Solid extruded aluminum air foil blades mounted in friction pivots for individual blade adjustment, spaced on 3/4" centers.

2. Key operated opposed blade damper which shall assure even air distribution of air across the grille face as well as volume control.

3. 1-1/4” wide flange with sponge rubber gasket.

4. Provide with 12” square backbox equal to the diffuser neck dimensions.

5. The blades shall be parallel to long dimension.

6. Model: Krueger 880H

C. Type 3 - (round diffuser type):

1. Shall be constructed of 4-cones. The inner 3-cone assembly shall be 3 position adjustable and shall be removable using a spring locking mechanism.

2. The removable core shall be supported by a safety cables.

3. Diffusers shall be constructed of 18 gage steel.

4. Outer cone shall be provided with anti-smudge characteristics.

5. Model: Krueger RM4

D. Type 4 - (Linear Ceiling Diffuser):

1. Slot diffuser shall have aluminum air deflector frames.

2. Diffuser shall have 1.5” slots, quantity of one (1) with 10” oval inlet, 72” in length.

3. Steel air pattern controller shall be adjustable and can be moved from side to side to create various air pattern configurations.

4. Spacer bars and pattern controllers shall be removable for on-site modification and trimming.

5. Slot diffuser shall be complete with factory end connections.

6. Style to fit installed ceiling type. Provide with a DFL, 1-Slot, Frame AA for exposed installations.

7. Factory supplied air plenums manufactured of heavy gauge wipe coat steel, internally insulated. Plenums shall be insulated with a side inlet collar.

8. Model: Krueger DesignFlo DFL

3.0 PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment in strict accordance with manufacturer's instructions. Rough-in or install per reflected ceiling plan or in locations instructed by Owner's Representative.

B. Provide approved air extractors behind all duct mounted supply registers in exposed ductwork.

C. When the final connection to an exhaust or return grille is made, a 12” minimum height plenum box must be supplied to all grilles. Plenum dimensions shall match grille size.

END OF SECTION 233713

SECTION 233726 - LOUVERS AND PENTHOUSES

1.0 PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide labor, materials, equipment and services as required for the complete installation designed in Contract Documents.

1.2 RELATED DOCUMENTS

A. All work under this section is subject to the Contract Documents. This Contractor shall be responsible for and governed by all the requirements therein.

1.3 SUBMITTALS TO THE ARCHITECT/ENGINEER

A. Louvers including all blade types, finishes and arrangements.

B. Provide original color charts for selection of finish.

C. Insulated panels including materials and finishes.

2.0 PART 2 - PRODUCTS

2.1 LOUVERS – 2”

A. Factory constructed aluminum louvers.

B. Provide mullions where blade lengths exceed 60 in.

C. With 1/2 " x 1/2" mesh, 14 gauge wire, aluminum birdscreen secured in removable frame, secured to back of louver.

D. Extruded sections 6063-T5 alloy, 0.063” minimum thickness, 2” deep, Double Drainable unless otherwise called for.

E. Sill extension and sill style as required by job conditions.

F. Kynar 500 70% finish color as selected at review of submittal. Custom color selection by architect.

G. Size, type and free areas indicated in location as called for on the Contract Documents.

H. "Stormproof" design with special curb to trap rain.

I. One-piece structural head, sill, and jambs.

J. All stainless steel fasteners.

K. Provide custom colors selected by the Architect.

L. Design Equipment: Greenheck ESD-202 (2") Double Drainable Blade.

M. Acceptable Make: Construction Specialties, Inc., Greenheck, Ruskin.

2.2 INSULATED BLANK OFF PANELS

A. General: Fabricate blank-off panels from materials and to sizes indicated and comply with the following requirements:

1. Outside Finish: Same as finish applied to louvers.

2. Inside Finish: Same as finish applied to louvers, but black in color.

3. Attach blank-off panels to back of louver frames with clips.

4. Attach blank-off panels to back of louver frames with stainless-steel sheet-metal screws.

B. Insulated, Blank-off Panels: Laminated metal-faced panels consisting of insulating core surfaced on back and front with metal sheets, complying with the following requirements:

1. Thickness: 2 inches (50 mm).

2. Metal Facing Sheets: Aluminum sheet, 0.032 inch (0.8mm) thick.

3. Insulating Core: Unfaced, rigid, glass-fiberboard complying with ASTM C 612, Class 1 and 2.

4. Edge Treatment: Trim perimeter edges of blank-off panels with louver manufacturer's standard extruded-aluminum channel frames 0.081 inch (2.06mm) thick, with corners mitered and with same finish as panels.

5. Seal perimeter joints between panel faces and louver frames with 1/8-by-1-inch (3.2-by-25mm) PVC compression gaskets.

3.0 PART 3 - EXECUTION

3.1 GENERAL

A. Install louvers and penthouses as per manufacturer's recommendations.

3.2 LOUVERS

A. Size called for is approximate wall/or masonry opening size. Adjust slightly to suit construction or coursing (review architectural drawings or field conditions for rough opening sizes). Louvers will be installed by General Contractor, assisted by this Contractor. Deliver in ample time. Slope ductwork and plenum to louver weephole or provide drain.

END OF SECTION 233726

SECTION 234000 - AIR FILTERS AND ACCESSORIES

1.0 PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide labor, materials, equipment and services as required for the complete installation designed in Contract Documents. Install equipment in strict accordance with manufacturer's instructions, and as detailed on the Contract Documents.

1.2 SUBMITTALS

A. Filter product data including certification date, pressure drops at the scheduled airflow, schedule of filter sizes for each system. All filter accessories, including framing systems, fastening clips, manometers, and differential pressure gauges.

1.3 QUALITY ASSURANCE

A. Filters shall comply with the requirements of ASHRAE Standard 52-76, and UL Standard 586 - Class II requirements. Filters shall also comply with requirements of applicable State and federal agencies. Filters shall not exceed a flame spread rating of 25 and smoke development rating of 50. The scheduled efficiencies refer to ASHRAE Standard 52-76 average efficiency.

1.4 CERTIFICATION

A. Submit with submittal, a test report prepared by an independent testing laboratory certifying compliance with above standards.

2.0 PART 2 - PRODUCTS

2.1 MEDIUM EFFICIENCY AIR FILTERS (MERV-8 - PLEATED TYPE)

A. The filter shall have a Minimum Efficiency Reporting Value of MERV 8 when evaluated under the guidelines of ASHRAE Standard 52.2-1999. It shall have an average dust spot efficiency of 25-30% and a minimum arrestance of 91% when evaluated under ASHRAE Standard 52.1-1992. The media shall maintain or increase in efficiency over the life of the filter. The filter shall be classified by Underwriters Laboratories as UL Class 2.

B. Filter media shall be a cotton and synthetic blend, lofted to a uniform depth of 0.18 in., and formed into a uniform radial pleats. There shall be at least 15 pleats per linear foot for the 2 in. deep filter. A welded wire grid, spot-welded on one-inch centers, treated for corrorion resistance, shall be bonded to the downstream side of the media to maintain the radial pleat and prevent media oscillation. An enclosing frame, of no less than 28 point high wet-strength beverage board shall provide a rigid and durable enclosure. The frame shall be bonded to the media to prevent air bypass, and include integral diagonal support members on the air entering and air exiting side to maintain uniform pleat spacing in varying airflows.

C. For the 2 in. filter, initial resistance to airflow shall not exceed 0.28” w.g. at an airflow of 500 fpm.

D. Design Equipment: Camfill-Farr 30/30.

E. Make: AAF, Camfill-Farr, Flanders.

2.2 FIBERGLASS (MERV-13)

A. Unless specifically noted otherwise, all coils and heat transfer devices shall be protected with 1” "throwaway" type fiberglass filters. The initial resistance at 300 fpm; shall not exceed .10” w.g.

B. Provide at least one filter for each system. Provide an additional set of filters to be used during the construction phase of the project.

C. Design Equipment: AAF.

D. Acceptable Makes: AAF, Camfill-Farr, Flanders.

2.3 LOW PRESSURE DROP CARTRIDGE TYPE FINAL FILTERS

A. Air Filters shall be high-efficiency ASHRAE pleat-in-pleat V-bank disposable type assembled in a compact and secure enclosing frame.

B. Filter media shall be of microfine glass formed into uniformly spaced pleats separated by fiberglass thread separators and formed into a minpleat pack design. Each minipleat pack shall be assembled into a V-bank configuration with an appropriate number of packs to obtain required pressure drop. The media packs shall be bonded to the inside periphery of the enclosing frame with a fire-retardant phosphorus-free sealant. The enclosing frame shall include galvanized steel channels bonded to the media pack to prevent air bypass. Extruded aluminum supports shall be placed on the air entering and air exiting sides to promote uniform airflow and assist in structural support. Rigid plastic end caps shall be mechanically fastened to the top and bottom of the enclosing structure to ensure a rigid and durable filter.

C. Filter shall include an integral header for installation in a standard 1 in. nominal filter track.

D. The filter shall have a Minimum Efficiency Reporting Value (MERV) 15, when evaluated under the guidelines of ASHRAE Standard 52.2-1999.

E. Initial resistance to airflow shall not exceed 0.22” w.g. at an airflow of 500 fpm.

F. Filter shall be rated by Underwriters Labratories as UL Class 2.

G. Design Equipment: Camfill-Farr Durafil MERV 15.

H. Acceptable Makes: AAF, Camfill-Farr, Flanders.

2.4 METAL FILTERS AT AIR INTAKES

A. Filters shall be cleanable with galvanized steel or aluminum frames. Filter media shall be aluminum. Install in galvanized steel rack with removable clips. Initial resistance shall not be more than .06" w.g. at 350 fpm. Provide filters of size and pressure dorp as scheduled at the required airflow.

B. Design Equipment: Airsan.

C. Acceptable Makes: AAF, Airsan, Farr.

2.5 MAGNEHELIC GAUGE

A. 3-7/8" diameter white dial diaphragm actuated air filter gauge. Guaranteed accurate to ± 2% of full scale. Pointer zero adjustment. Provide all accessories including adaptors, mounting panel, pressure tips, fittings, tubing, vent valves.

B. Design Equipment: Dwyer.

3.0 PART 3 - EXECUTION

3.1 GENERAL

A. Provide one set of spare filters of each type for each system requiring a filter. Install first set of filters when units are initially installed (as opposed to started). Change filters as required during construction period to maintain systems in a clean manner throughout the construction period. Remove dirty set and install one clean set prior to Owner occupancy. If original filters do not require replacement, as determined by Owner's Representative, then deliver final set to Owner and obtain receipt. Seal between filter frames to prevent leakage. Install on frames without racking to eliminate air bypass.

3.2 MANOMETERS

A. Provide for each filter set.

3.3 MAGHEHELIC GAUGES

A. Provide for each filter set.

END OF SECTION 234000

SECTION 236213 - AIR COOLED-CONDENSING UNITS

1.0 PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services as required for the complete installation designed in Contract Documents.

1.2 SUBMITTALS

A. Air-cooled condensing unit, complete with accessories.

B. Complete wiring and piping diagrams, showing all piping and control interconnection.

C. Electrical information, to include volts, frequency, number of phases, minimum supply circuit conductor ampacity, the maximum rating of the branch circuit short circuit and ground fault protective device, and the short circuit rating of the motor controllers or industrial control panel.

1.3 GENERAL REQUIREMENTS

A. Equipment manufacturer shall be responsible for the following:

1. Furnish complete installation drawings, templates, wiring diagrams and instruction manuals for the equipment. Manufacturer's "Installation Instructions" and "Start-up and Service Instruction" and catalog for wiring and piping shall become a part of the Contract Documents.

2. Provide additional copies of above data for O&M Manual.

3. Provide refrigerant piping diagram prior to installation showing exact location and arrangement of piping thermostats, flow switches, gauges, thermometers and insertion wells required.

4. Supervise and check installation for compliance with manufacturer's recommendations.

5. Furnish rubber-in-shear vibration mounting equipment to prevent transmission of machine vibration to the building structure.

6. Complete start-up for each unit shall be performed under the direction of the manufacturers authorized representative.

B. Contractor Shall:

1. Provide piping, valves and accessories to connect the condensing units to their respective units, including miscellaneous devices to make a complete and operable refrigeration system.

2. Provide one year, 24-hour service and guarantee, from date of final acceptance.

C. Electrical Wiring:

1. Division 26 shall provide power wiring to condensing unit.

2. Division 23 shall provide control wiring interlocks at units and interlocks to air handling units as required.

D. Start-Up, Testing and Instructions:

1. Provide complete installation, testing, wiring, start-up, and instructions to Owner's Representative's.

2.0 PART 2 - PRODUCTS

2.1 AIR-COOLED CONDENSING UNITS

A. General:

1. Air-cooled condensing units shall have scroll compressors and are factory assembled and wired. Each unit shall ship from the factory with a nitrogen holding charge. Units shall be constructed of 14- gauge welded galvanized steel frame with 14 and 16-gauge galvanized steel panels and access doors.

2. Units shall have factory mounted, louvered, full-length steel grilles to protect the condenser coils and piping. Unit surface shall be finished with an air-dry paint. This air-dry paint finish shall be durable enough to withstand a minimum of 672-consecutive-hour salt spray application in accordance with standard ASTM B117.

B. Controls:

1. The factory controller is an application-specific, programmable controller that is factory installed and designed to control packaged HVAC equipment. A seven-inch user interface features a touch sensitive color screen shall be provided. that provides status, performance monitoring, scheduling changes, and operating adjustments.

2. Operating controls for the units shall be integrated with the temperature control system.

3. Refrigerant Management

a) Split systems can have significantly more refrigerant than packaged systems and thus require controls to reliably manage this excess refrigerant. Each compressor shall have crankcase heaters installed, properly sized to minimize the amount of liquid refrigerant present in the oil sump during off cycles. Additionally, the condensing unit shall have controls to initiate refrigerant isolation at system shut down on each refrigerant circuit. To be operational, the refrigerant isolation cycle requires a field-installed isolation solenoid valve on the common liquid line near the evaporator.

B. Compressors:

1. Refrigeration System – Provide number of scroll compressors as called for on schedule and provided as basis of design, shall be provided with the following:

a) Dual refrigeration circuit with integral subcooling circuit.

b) Provide minimum of one digital scroll compressor per air cooled condensing unit. One digital scroll for low capacity modulation down to 17%.

c) Crankcase heater

d) Internal temperature and current sensitive motor overloads

e) Factory installed liquid line filter drier

f) Phase loss/reverse rotation monitor

g) Liquid line service valve with gauge port

h) Suction line service valve(with gauge port

i) External high pressure cutout device

j) External low pressure cutout device

k) Evaporator defrost control

l) Loss of charge protection

m) Provide all compressors with BRF Hushcore compressor covers.

C. Condenser Coils:

1. Condenser coils of aluminum fins mechanically bonded to seamless copper tubing, pressure tested for 660 psi working pressure.

2. Provide with perforated steel hail guards.

3. Tubes cleaned, dehydrated, and sealed.

4. Provide with low sound VFD Compressor fans.

D. Refrigeration Circuits:

1. Refrigeration circuits with sub-cooling coils, service valves gauge ports, and dryers.

2. Unit shall utilize R-454B refrigerant.

E. Leak Detection:

1. The condenser section shall accept an isolated closure input suitable for customer connection to hard wire the leak detection system in the paired air handler or mechanical room. Refer to “A2L refrigerant leak detection/safety controls” in specification 237313 for additional information.

F. Condenser Fans and Motors:

1. Condenser fans shall be vertical discharge, direct drive fans, statically balanced, with aluminum blades and zinc plated steel hubs. Condenser fan motors shall be three-phase motors with permanently lubricated ball bearings, built in current and thermal overload protection and weather-tight slingers over motor bearings.

G. Accessories:

1. Convenience outlet

a) Factory shall provide 115-volt control circuit which includes fusing and control power transformer. The unit shall be wired with magnetic contactors for compressor and condenser motors and high pressure cutouts. Charge isolation, reset relay and anti-recycle compressor timer shall be provided.

2. Phase Monitor

a) The unit shall be equipped with a phase monitor in the control box. The phase monitor shall protect against phase loss, imbalance and reversal of the line voltage.

3. Disconnect switch:

a) Disconnect switch shall be mounted in the control box and provide for interruption of power for servicing the unit. Lugs shall be suitable for copper wires only. No overcurrent or short circuit protection shall be provided for unit by this switch. Option shall include external handle to allow power disconnection without having to open the control box door.

4. Spring Isolators:

a) Spring vibration isolators shall be supplied for field installation under the unit base to minimize transmission of unit vibrations. Isolators shall consist of a cast, spring loaded, telescoping housing as the isolation medium. Mountings shall include built-in leveling bolts, resilient inserts that act as centering guides, and ribbed neoprene acoustical pads bonded to the bottom of the isolator. The kit shall include instructions for field installation

H. Design Equipment: Trane RAUK

I. Make: Carrier, Daikin, Trane.

2.2 REFRIGERATION ACCESSORIES

A. Filter Dryers:

1. Liquid lines dryer ahead of solenoid valves in each system.

2. Replaceable cartridge type.

3. Make: Ansul, McIntire, Mueller, Sporlan.

B. Sight Glass:

1. In each liquid line close to evaporator, after filter dryer.

2. Make: Ansul Super Dry-Ey, Henry; with elements to act as moisture indicator; Sporlan.

C. Thermal Expansion Valve:

1. In each liquid line at the evaporator coil.

2. Make: Sporlan.

D. Solenoid Valve:

1. In each liquid line at the evaporator coil ahead of the expansion valve.

2. Make: Alco, Sporlan.

E. Shut-Off Valves:

1. To isolate equipment components, packless type.

2. Make: Henry, Mueller, Superior.

F. Charging Valve:

1. Locate and install at a point to facilitate charging of the system.

G. Provide unit with BRD Hush Cover on all compressors.

1. Outer Jacket: 16 oz./yd.2 PTFE silicone impregnated fiberglass cloth.

2. Acoustic Barrier: Barium sulfate loaded vinyl (2 lb. density)

3. Insulation: Fiberglass needle mat (11lbs./ft.3 density)

4. Inner Jacket: 16 oz./yd.2 PTFE silicone impregnated fiberglass cloth

5. Performance Data:

Test Frequency (in Hz)	Noise Reduction (in dB)
315	1
400	6
500	10
630	12
800	12
1000	21
1250	23
1600	25
200	26
2500	26
3150	26

3.0 PART 3 - EXECUTION

3.1 INSTALLATION

A. Connect services to the unit where called for, in complete accordance with the Manufacturer's Installation Instructions. Furnish Division 26 with wiring diagrams and electrical data to permit power wiring connections to the unit. Provide control wiring serving air handling unit associated condensing unit, and the auxiliary control panel in accordance with Section "Electric Wiring." Charge system with Refrigerant after leak testing, and in accordance with Manufacturer's Installation Instructions. Provide roof equipment support rails.

END OF SECTION 236213

SECTION 237219 – AIR TO AIR ENERGY RECOVERY EQUIPMENT

1.0 PART 1 – GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services to perform operations required for the complete installation and related Work as required in Contract Documents.

B. Provide specified Air to Air Energy Recovery Ventilators (ERV) or Energy Recovery Units (ERU) as specified within this section

1.2 SUBMITTALS

A. Product data: For each type or model of Energy Recovery Ventilator, include the following:

1. Unit performance data for both Supply Air and Exhaust Air, with system operating conditions indicated.

2. Enthalpy plate performance data for both summer and winter operation.

3. Motor ratings and unit electrical characteristics.

4. Dimensioned drawings for each type of installation, showing isometric and plan views, to include location of attached ductwork and service clearance requirements.

5. Estimated gross weight of each installed unit.

6. Filter types, quantities, and sizes

B. Shop Drawings: For air-to-air energy recovery ventilators, 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.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Drawings and general provisions of the contract, including Contract General Requirements

B. Division 23 specifications

C. Section 230923 Temperature Controls

1.4 QUALITY ASSURANCE

A. Manufacturer to be in business of manufacturing energy recover ventilators for a minimum of 5 years. References of similar installations shall be provided to the Engineer upon request for review.

B. Source Limitations: Obtain Air-to-Air Energy Recovery Ventilator with all appurtenant components or accessories from a single manufacturer.

C. For the actual fabrication, installation, and testing of work under this section, use only thoroughly trained and experienced workers completely familiar with the items required and with the manufacturer's current recommended methods of installation.

D. The ERV core shall be warranted to be free of manufacturing defects and to retain its functional characteristics, under circumstances of normal use, for a period of ten (10) years from the date of purchase. The balance-of-unit shall be warranted to be free of manufacturing defects and to retain its functional characteristics, under circumstances of normal use, for a period of two (2) years from the date of installation.

E. Manufacturer shall be able to provide evidence of independent testing of the core by Underwriters Laboratory (UL), verifying a maximum flame spread index (FSI) of 25 and a maximum smoke developed index (SDI) of 50 thereby meeting NFPA90A and NFPA 90B requirements for materials in a compartment handling air intended for circulation through a duct system. The method of test shall be UL Standard 723.

F. The energy recovery cores used in these products shall be third party Certified by AHRI under its Standard 1060 for Energy Recovery Ventilators. AHRI published certifications shall confirm manufacturer’s published performance for airflow, static pressure, temperature and total effectiveness, purge air (OACF) and exhaust air leakage (EATR). Products that are not currently AHRI certified will not be accepted. OACF shall be no more than 1.02 and EATR shall be at 0% against balanced airflow.

G. Entire unit shall be listed under UL 1812 Standard for Ducted Air to Air Heat Exchangers and comply with CSA Standard 22.2.

H. Units intended for outdoor use shall be rain tested in accordance with UL 1812 Section 67.

I. Unit to be factory tested prior to shipping: Motor Dielectric Voltage-Withstand Bench Test, Unit Dielectric Voltage-Withstand Test, Continuity of Internal Control Circuits Test, Unit Amperage Test.

2.0 PART 2 – PRODUCTS

2.1 ENERGY RECOVERY VENTILATOR

A. CONSTRUCTION

1. Fixed-plate energy-exchange element. Energy-exchange module shall be of fixed-plate cross-flow construction, with no moving parts. Energy recovery core shall be of the total enthalpy type, capable of transferring both sensible and latent energy between airstreams.

2. No condensate drain pans or drains shall be allowed and unit shall be capable of operating in winter and summer conditions without generating condensate.

3. The unit case shall be double wall insulated metal cabinet, fabricated to permit access to internal components for maintenance. Outside casing: 20 gauge, galvanized (G90) steel meeting ASTM A653 for components that do not receive a painted finish.

4. Unit shall have a fused disconnect with single-point power connection.

5. Flange components shall be provided suitable for connection of ductwork.

6. Access doors shall be hinged and provide easy access to blowers, energy transfer elements, and filters. Panel shall be gasketed to provide air-tight seal.

7. Unit walls and doors shall be insulated with 1 inch, 4 pound density, foil/scrim faced, high density fiberglass board insulation, providing a cleanable surface and eliminating the possibility of exposing the fresh air to glass fibers, and with a minimum R-value of 4.3.

8. Energy-exchange element shall be protected by a MERV 13 (outside air) and MERV 8 (exhaust air) rated 2” nominal pleated, disposable filters. Provide filter at exhaust air inlet. Provide additional set of filters.

9. Motorized isolation dampers in outside air and relief air discharges.

10. Blower motors shall be EC motors, premium efficiency TEFC thermally protected with automatic reset, or supplied with starters. Shall be statically and dynamically balanced and designed for continuous operation.

11. Factory supplied and mounted EC motors on both air streams.

12. Unit shall be BACNet capable.

B. Design Equipment: RenewAire HE-07

C. Makes Multistack , ConsERV, Renewaire.

3.0 PART 3 – EXECUTION

3.1 INSTALLATION

A. Prior to start of installation, examine area and conditions to verify correct location for compliance with installation tolerances and other conditions affecting unit performance.

B. Examine roughing-in of plumbing, electrical and HVAC services to verify actual location and compliance with unit requirements.

C. Proceed with installation only after all unsatisfactory conditions have been corrected.

D. Connect ductwork per AMCA, ASHRAE, and SMACNA guidelines.

E. Provide service clearances as indicated on the plans.

F. Provide a structurally suitable support for the base of any wall mounted or hung units.

G. Provide roof curb in compliance with section 230550 for roof mounted equipment.

END OF SECTION 237219

SECTION 237313 - AIR HANDLING UNIT

1.0 PART 1 – GENERAL

1.1 DESCRIPTION

A. Provide labor, materials, equipment and services as required for the complete installation as shown on the Contract Documents.

1.2 RELATED SECTIONS

A. Section 230010 - Basic Mechanical Requirements

B. Section 230513 – Motors

C. Section 230514 – Electric Wiring

D. Section 230923 – Temperature Controls

E. Section 23400 – Air Filters and Accessories

F. Section 262923 - Adjustable Speed Drives

1.3 REFERENCES

A. AMCA Publication 99 – Standards Handbook.

B. AMCA Publication 611 – Certified Ratings Program – Airflow Measurement Performance

C. AMCA Standard 500-D – Laboratory Methods of Testing Dampers for Rating.

D. ANSI/ABMA Standard 9 - Load Ratings and Fatigue Life for Ball Bearings.

E. ANSI/AMCA Standard 204 – Balance Quality and Vibration Levels for Fans.

F. ANSI/AHRI Standard 410 - Forced Circulation Air-Cooling and Air-Heating Coils.

G. ANSI/AHRI Standard 430 - Central Station Air Handling Units.

H. ANSI/NEMA MG 1 – Motors and Generators.

I. ANSI/UL 900 – Standard for Safety Air Filter Units.

J. AHRI Standard 260 – Sound rating of Ducted Air Moving and Conditioning Equipment.

K. ASHRAE Standard 111 – Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems.

L. ASTM C1071 – Thermal and Acoustic Insulation (Mineral Fiber, Duct Lining Material).

M. ASTM C1338 – Standard Test Method for Determining Fungi Resistance of Insulation Material and Facings.

N. NFPA 70 – National Electrical Code®.

O. NFPA 90A – Standard for the Installation of Air Conditioning and Ventilation Systems.

P. UL 1995 – Standard for Safety Heating and Cooling Equipment

1.4 QUALITY ASSURANCE

A. Air Coils: Certify capacities, pressure drops and selection procedures in accordance with current AHRI Standard 410.

B. Air handling units with fan sections utilizing single fans shall be rated and certified in accordance with AHRI Standard 430.

C. Air handling units with fan sections utilizing multiple fans shall be rated in accordance with AHRI Standard 430 for airflow, static pressure, and fan speed performance.

D. ISO 9001 Certification.

1.5 SUBMITTALS

A. No equipment shall be fabricated or delivered until the receipt of approved shop drawings from the Engineer.

B. Wind Restraint submittal data per specification 230550.

C. AHU manufacturer shall provide the following information with each shop drawing/product data submission:

1. Dimensioned arrangement drawings for each AHU including a plan and elevation view of the assembled unit with overall dimensions, lift points, unit shipping split locations and dimensions, installation and operating weights, and installation, operation and service clearances.

2. All electrical, piping, and ductwork requirements, including sizes, connection locations, and connection method recommendations.

3. Each component of the unit shall be identified and mechanical specifications shall be provided for unit and accessories describing construction, components, and options.

4. All performance data, including capacities and airside and waterside pressure drops, for components.

5. Fan curves shall be provided for fans with the design operating points indicated. Data shall be corrected to actual operating conditions, temperatures, and altitudes.

6. For units with multiple fans, a fan curve shall be provided showing the performance of the entire bank of fans at design conditions. In addition, a fan curve shall be provided showing the performance of each individual fan in the bank of fans at design conditions. Finally, a fan curve shall be provide showing the performance of the bank of fans when one fan is down. The percent redundancy of the bank of fans with one fan down shall be noted on the fan curve or in the tabulated fan data.

7. A filter schedule that complies with Section 234000 must be provided for each air handling unit supplied by the air handling unit manufacturer. Schedule shall detail unit tag, unit size, corresponding filter section location within the AHU, filter arrangement (e.g. angled/flat), filter depth, filter type (e.g. pleated media), MERV rating, and filter quantity and size.

8. A schedule detailing necessary trap height shall be provided for each air handling unit. Schedule shall detail unit tag, unit size, appropriate trap schematic with recommended trap dimensions, and unit supplied base rail height. Contractor shall be responsible for additional trap height required for trapping and insulation beyond the unit supplied base rail height by adequate housekeeping pad.

9. An electrical MCA – MOP schedule shall be provided for each electrical circuit to which field-power must be supplied. Schedule to detail unit tag, circuit description, voltage/phase/hertz, Minimum Circuit Ampacity (MCA), and calculated Maximum Overcurrent Protection (MOP).

10. Sound data shall be provided using AHRI 260 test methods. Unit discharge, inlet, and radiated sound power levels in dB shall be provided for 63, 125, 250, 500, 1000, 2000, 4000, and 8000 Hz.

11. The AHU manufacturer shall list any exceptions to the specification.

D. Unit shall conform in all respects to the 2022 revision of ASHRAE Standard 15, independent of whether specific details are enumerated within this specification.

1.6 REGULATORY REQUIREMENTS

A. Agency Listings/Certifications

1. Unit shall be manufactured to conform to UL 1995 and shall be listed by either UL/CUL or ETL. Units shall be provided with listing agency label affixed to the unit. In the event the unit is not UL/CUL or ETL approved, the contractor shall, at his/her expense, provide for a field inspection by a UL/CUL or ETL representative to verify conformance. If necessary, contractor shall perform modifications to the unit to comply with UL/CUL or ETL as directed by the representative, at no additional expense to the owner.

2. Certify air handling units in accordance with AHRI Standard 430. Units shall be provided with certification label affixed to the unit. If air handling units are not certified in accordance with AHRI Standard 430, contractor shall be responsible for expenses associated with testing of units after installation to verify performance of fan(s). Any costs incurred to adjust fans to meet scheduled capacities shall be the sole responsibility of the contractor.

3. Certify air handling coils in accordance with AHRI Standard 410. Units shall be provided with certification label affixed to the unit. If air handling coils are not certified in accordance with AHRI Standard 410, contractor shall be responsible for expenses associated with testing of coils after installation to verify performance of coil(s). Any costs incurred to adjust coils to meet scheduled capacities shall be the sole responsibility of the contractor.

4. Certify airflow monitoring stations are tested for differential pressure in accordance with AMCA 611 in an AMCA registered laboratory and comply with the requirements of the AMCA Certified Ratings Program. Factory furnished air flow stations shall comply with the requirements of section 230923.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

B. Units shall ship fully assembled up to practical shipping and rigging limitations. Units not shipped fully assembled shall have tags and airflow arrows on each section to indicate location and orientation in direction of airflow. Shipping splits shall be clearly defined on submittal drawings. Cost associated with non-conformance to shop drawings shall be the responsibility of the manufacturer. Each section shall have lifting lugs for field rigging and final placement of AHU sections. Indoor AHUs less than 100 inches wide shall allow for forklift transport for maneuverability on jobsite.

C. Deliver units to jobsite with fan motor(s), sheave(s), and belt(s) completely assembled and mounted in units.

D. Indoor air handling units shall be shipped in a clear shrink-wrap or stretch-wrap to protect unit from in-transit rain and debris per ASHRAE 62.1 recommendations.

E. Installing contractor shall be responsible for storing AHU in a clean, dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

1.8 START-UP AND OPERATING REQUIREMENTS

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters in place, bearings lubricated (if applicable), condensate properly trapped, piping connections verified and leak-tested, belts aligned and tensioned, all shipping braces removed, bearing set screws torqued, and fan has been test run under observation.

1.9 WARRANTY

A. AHU manufacturer shall provide, at no additional cost, a standard parts warranty that covers a period of five (5) years from unit start-up or sixty-six (66) months from shipment, whichever occurs first. This warrants that all products are free from defects in material and workmanship and shall meet the capacities and ratings set forth in the equipment manufacturer's catalog and bulletins.

2.0 PART 2 - PRODUCTS

2.1 INDOOR AND ROOFTOP AIR HANDLING UNITS:

2.2 GENERAL

A. Unit layout and configuration shall be as defined in project plans and schedule.

B. Unit manufacturer to provide an integral base frame to support all sections of unit and raise unit for proper trapping. Contractor will be responsible for providing additional height of the housekeeping pad when indoor air handling unit base frame is not of sufficient height to properly trap unit. Unit base frames not constructed of galvanized steel shall be chemically cleaned and coated with both a rust-inhibiting primer and finished coat of rust-inhibiting enamel.

C. Entire outdoor air handling unit shall have a 6-inch full perimeter base rail for structural rigidity and condensate trapping. Indoor Units shall have 4.0-inch integral base frames.

D. Ceiling hung units shall be provided with vibration isolation.

E. All floor mounted unit shall be provided with concrete equipment pad.

2.3 UNIT CASING

A. Unit manufacturer shall ship separate segments so unit can be broken down for ease of installation in tight spaces. The entire air handler shall be constructed of galvanized steel. Indoor air handling unit casing finish to meet ASTM B117 250-hour salt-spray test. The removal of access panels or access doors shall not affect the structural integrity of the unit. All removable panels shall be gasketed. All doors shall have gasketing around full perimeter to prevent air leakage. Contractor shall be responsible to provide connection flanges and all other framework that is needed to properly support the unit.

1. Rooftop Units:

a) Inlet Hoods shall be provided on the outside air openings and equipped with high performance moisture eliminators to minimize water carryover from the outside into the unit casing. The eliminators shall also perform the function of a birdscreen to prevent nesting. The inlet hood shall be designed to accept an airflow station where shown on controls drawings.

b) Exhaust Hoods shall be provided on the exhaust air openings and equipped with birdscreens to prevent nesting. The exhaust hood shall be designed to accept an airflow station where shown on controls drawings.

c) Outdoor unit roofs shall incorporate a standing seam on the exterior to ensure a rigid roof construction and prevent water infiltration. Roof assembly shall overhang all walls by 1.5" minimum to prevent sheeting from roof to side panels. Rain gutters shall also be provided over all doors shorter than total unit height to direct rain water away from the door assembly. Outdoor roofs shall be sloped, not less than .125" per linear foot. Where outdoor units are shipped in multiple sections, provide a standing seam joiner at each split with adhesive, hardware and cover strips for field joining by the mechanical contractor.

d) **A roof curb shall be provided to maintain a minimum of 30" between the finished roof and bottom of the unit baserails.**

e) External surface of the unit casing shall be coated with a water based polyurethane paint, color slate grey. Unit paint shall be able to withstand a salt spray test in accordance with ASTM B117 for a minimum of 500-hour spray test.

f) Adjustable Speed Drives: Rooftop units shall be provided with factory variable frequency drives (VFD), including factory wired. Rooftop units shall be single point connection. 262923 - Adjustable Speed Drives

B. Casing performance – Casing air leakage shall not exceed 2% of design airflow at the specified casing pressure.

C. Air leakage shall be determined at a casing static pressure of 6 inches w.g. Specified air leakage shall be accomplished without the use of caulk. Total estimated air leakage shall be reported for each unit in CFM, as a percentage of supply air, and as an ASHRAE 111 Leakage Class.

D. Under 55°F supply air temperature and design conditions on the exterior of the unit of 81°F dry bulb and 73°F wet bulb, condensation shall not form on the casing exterior. The AHU manufacturer shall provide tested casing thermal performance for the scheduled supply air temperature plotted on a psychrometric chart. The design condition on the exterior of the unit shall also be plotted on the chart. If tested casing thermal data is not available, AHU manufacturer shall provide, in writing to the Engineer and Owner, a guarantee against condensation forming on the unit exterior at the stated design conditions above. The guarantee shall note that the AHU manufacturer will cover all expenses associated with modifying units in the field should external condensate form on them. In lieu of AHU manufacturer providing a written guarantee, the installing contractor must provide additional external insulation on AHU to prevent condensation.

E. Unit casing (wall/floor/pressure bulkhead roof panels and doors) shall be able to withstand up to 1.5 times design static pressure up to +8" w.g. in all positive pressure sections and -8" w.g. in all negative pressure sections, whichever is less, and shall not exceed 0.0042" per inch of panel span (L/240).

F. Floor panels shall be double-wall construction and designed to support a 300-lb load during maintenance activities and shall deflect no more than 0.0042" per inch of panel span.

G. Unit casing panels shall be 2" double-wall construction, with solid galvanized exterior and solid Interior Liner galvanized interior, to facilitate cleaning of unit interior.

H. Unit casing panels (pressure bulkhead roof panels, walls, floor) and doors shall be provided with a minimum thermal resistance (R-value) of 13 $Hr*Ft^2*°F/BTU$.

I. Unit casing panels (pressure bulkhead roof panels, walls, floor) and external structural frame members shall be completely insulated filling the entire panel cavity in all directions so that no voids exist. Panel insulation shall comply with NFPA 90A.

J. Structural frame must not extend from air-handling unit interior to exterior. All component and panel support structure must be internal to AHU. Casing panel inner liners must not extend to the exterior of the unit or contact the exterior frame. A mid-span, no-through-metal, internal thermal break shall be provided for all unit casing panels.

K. Access panels and/or access doors shall be provided in all sections to allow easy access to drain pan, coil(s), motor, drive components and bearings for cleaning, inspection, and maintenance.

L. Access panels and doors shall be fully removable without the use of specialized tools to allow complete access of interior surfaces.

M. Treadplate shall be applied to the unit floor to improve the walking surface in those unit sections where the floor is fully accessible, and not impeded by internal structural or functional features. Treadplate shall be included in units that are 60-inches tall or larger.

2.4 SOUND PERFORMANCE

A. The AHU manufacturer shall provide sound power levels for AHUs/RTU's at the octave bands indicated below. Sound power levels at each octave band shall not exceed listed criteria by more than 3 dB. In the event that the required levels are not met, the manufacturer shall provide corrective measures to achieve the levels specified in the schedules below, at no additional cost to the Owner.

Sound Power Levels (L_w) $dBre10^{-12}$ W								
B-RTU-01	**Octave Band Center Frequency (Hz)**							
	63	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
Discharge	85	81	73	71	69	66	60	54
Ducted Inlet	78	75	75	67	66	69	64	55
Casing	82	80	84	85	77	64	61	53

2.5 ACCESS DOORS

A. Access doors shall be 2" double-wall construction. Interior and exterior shall be of the same construction as the interior and exterior wall panels.

B. All doors downstream of cooling coils shall be provided with a thermal break construction of door panel and door frame.

C. Gasketing shall be provided around the full perimeter of the doors to prevent air leakage.

D. Door hardware shall be surface-mounted to prevent through-cabinet penetrations that could likely weaken the casing leakage and thermal performance.

E. Handle hardware shall be designed to prevent unintended closure.

F. Access doors shall be hinged and removable without the use of specialized tools to allow.

G. Hinges shall be interchangeable with the door handle hardware to allow for alternating door swing in the field to minimize access interference due to unforeseen job site obstructions.

H. Door handle hardware shall be adjustable and visually indicate locking position of door latch external to the section.

I. All doors shall be a minimum 60” high when sufficient height is available, or the maximum height allowed by the unit height.

J. A single door handle shall be provided for each door linking multiple latching points necessary to maintain the specified air leakage integrity of the unit.

K. Shatterproof windows shall be provided at fan sections, access sections, between coils, filter sections and mixed air sections. Window shall be thermal pane and capable of withstanding unit operating pressures.

2.6 PRIMARY DRAIN PANS

A. All cooling coil sections shall be provided with an insulated, double-wall, stainless steel drain pan.

B. The drain pan shall be designed in accordance with ASHRAE 62.1 being of sufficient size to collect all condensation produced from the coil and sloped in two planes, pitched toward drain connections, promoting positive drainage to eliminate stagnant water conditions when unit is installed level and trapped per manufacturer's requirements.

C. The outlet shall be located at the lowest point of the pan and shall be sufficient diameter to preclude drain pan overflow under any normally expected operating condition.

D. All drain pan threaded connections shall be visible external to the unit. Threaded connections under the unit floor shall not be accepted.

E. Drain connections shall be of the same material as the primary drain pan and shall extend a minimum 2-1/2” beyond the base to ensure adequate room for field piping of condensate traps.

F. The installing contractor is responsible to ensure the unit is installed level, trapped in accordance with the manufacturer's requirements, and visually inspected to ensure proper drainage of condensate.

G. Coil support members inside the drain pan shall be of the same material as the drain pan and coil casing.

H. Drain pans shall be provided for heating coils, access sections, and mixing sections as indicated in the plans.

2.7 FANS

A. Fan sections shall have a minimum of one access door located on the drive side of the unit to allow inspection and maintenance of the fan, motor, and drive components.

B. Provide fans of type and class as specified on the schedule. Fan shafts shall be solid steel, coated with a rust-inhibiting coating, and properly designed so that fan shaft does not pass through first critical speed as unit comes up to rated RPM. All fans shall be statically and dynamically tested by the manufacturer for vibration and alignment as an assembly at the operating RPM to meet design specifications. Fans controlled by variable frequency drives shall be statically and dynamically tested for vibration and alignment at speeds between 25% and 100% of design RPM. If fans are not factory-tested for vibration and alignment, the contractor shall be responsible for cost and labor associated with field balancing and certified vibration performance. Fan wheels shall be keyed to fan shafts to prevent slipping.

C. All direct-drive plenum fans, shall be mounted on spring isolation bases. Internally-mounted motor shall be on the same isolation base. Fan and motor shall be internally isolated with spring isolators. Unit sizes up to nominal 4,000 cfm shall have 1-inch springs. Unit sizes larger than nominal 4,000 cfm shall have 2-inch spring isolators. A flexible connection (e.g. canvas duct) shall be installed between fan and unit casing to ensure complete isolation. Flexible connection shall comply with NFPA 90A and UL 181 requirements. If fans and motors are not internally isolated, then the entire unit shall be externally isolated from the building, including supply and return duct work, piping, and electrical connections. External isolation shall be furnished by the installing contractor in order to avoid transmission of noise and vibration through the ductwork and building structure.

D. Supply air fan section shall include a third wall acoustical liner to meet acoustical requirements. The liner shall be fabricated from a perforated material to prevent corrosion and designed to completely encapsulate fiberglass insulation. The perforation spacing and hole size shall be such as to prevent insulation breakaway, flake off, or delamination when tested at 9000 fpm, in accordance with UL 181 or ASTM C1071. Insulation material must be resistant to fungi in accordance with ASTM C1338.

2.8 MOTORS AND DRIVES

A. Motors shall meet or exceed all NEMA Standards Publication MG 1 – 2006 requirements and comply with NEMA Premium efficiency levels when applicable. Motors shall comply with applicable requirements of NEC and shall be UL Listed.

B. Fan Motors shall be heavy duty, NEMA Premium efficient, all motors shall be provided per Section 230513

C. Direct-driven fan sections shall use 2-pole (3600 rpm), 4-pole (1800 rpm), or 6-pole (1200 rpm) motors, NEMA Design B, with Class B insulation to operate continuously at 104°F (40°C) ambient without tripping of overloads. Multiple fan selections utilizing 8-pole (900 rpm) motors are unacceptable due to motor inefficiency, cost, and replacement lead times.

D. Motors shall have a +/- 10 percent voltage utilization range to protect against voltage variation.

E. Manufacturer shall provide for each fan a nameplate with the following information to assist air balance contractor in start up and service personnel in maintenance:

1. Fan and motor part number

2. Fan and motor bushing part number

3. Fan design RPM and motor HP

F. Overload Panel: Overload panel is a factory mounted NEMA Type 1 enclosure for indoor units, and NEMA Type 4 enclosure for outdoor units. The panel will take one field VFD power input and distribute to 2, 4 or 6 fans. These fans will be protected by manual motor protectors and over-current protection (fuse or IEC style circuit breaker), one per fan. Auxiliary contacts are wired in series to terminal blocks for generic trip signaling. Panel is rated for WYE power systems up to 600V. For air handlers configured with both supply and return fan sections, a factory mounted enclosure shall be provided for each section.

G. For single fan motors not supplied with a factory mounted and wired starter or VFD, the unit manufacturer shall supply a 4x4 NEMA 4 junction box on the exterior of the fan section(s) with wiring, prewired to the fan motor, to allow for ease of field installation of a starter or VFD.

H. Rooftop units shall be single point connection with factory provided variable frequency drives. Variable frequency drives shall be provide to meet requirements in specification 262923 - Adjustable Speed Drives.

2.9 HYDRONIC COILS

A. Coils section side panel shall be removable to allow for removal and replacement of coils without impacting the structural integrity of the unit.

B. Install coils such that headers and return bends are enclosed by unit casing to ensure that if condensate forms on the header or return bends, it is captured by the drain pan under the coil.

C. Coils shall be manufactured with plate fins to minimize water carryover and maximize airside thermal efficiency. Fin tube holes shall have drawn and belled collars to maintain consistent fin spacing to ensure performance and air pressure drop across the coil as scheduled. Tubes shall be mechanically expanded and bonded to fin collars for maximum thermal conductivity. Use of soldering or tinning during the fin-to-tube bonding process is not acceptable due to the inherent thermal stress and possible loss of bonding at that joint.

D. Construct coil casings of galvanized steel for heating coils and stainless steel for cooling coils. End supports and tube sheets shall have belled tube holes to minimize wear of the tube wall during thermal expansion and contraction of the tube.

E. All coils shall be completely cleaned prior to installation into the air handling unit. Complete fin bundle shall be degreased and cleaned to remove any lubricants used in the manufacturing of the fins, or dirt that may have accumulated, in order to minimize the chance for water carryover.

F. When two or more cooling coils are stacked in the unit, an intermediate drain pan shall be installed between each coil. The intermediate drain pan shall be designed being of sufficient size to collect all condensation produced from the coil and sloped to promote positive drainage to eliminate stagnant water conditions. The intermediate drain pan shall be constructed of the same material as the primary drain pan.

G. The intermediate drain pan shall begin at the leading face of the water-producing device and be of sufficient length extending downstream to prevent condensate from passing through the air stream of the lower coil.

H. Intermediate drain pan shall include downspouts to direct condensate to the primary drain pan. The intermediate drain pan outlet shall be located at the lowest point of the pan and shall be sufficient diameter to preclude drain pan overflow under any normally expected operating condition.

I. Hydronic Coils (Heating Hot Water)

1. Non-ferrous heating coils, 125 psi working pressure, designed to relieve expansion and contraction strains.

2. Aluminum fins, helically wound, or plate type with expanded tube. Completely drainable and able to be vented.

3. Minimum 16 gauge galvanized casing, 5/8” O.D. 0.035” thick copper tubes with 0.035” thick "U" bends, aluminum fins, for coils.

4. Coils tested at 300 psig then leak tested at 200 psig with air pressure under water.

5. Hot water heating coils, serpentine type, number rows and arrangement as called for; same end connections with vent chamber on return end.

6. Provide with turbulators.

7. Supply and return header connections shall be clearly labeled on unit exterior such that direction of coil water-flow is counter to direction of unit air-flow.

8. Hydronic coils shall be supplied with factory installed extended drain and vent piping to the unit exterior with a 3/8 black steel pipe and cap.

J. Freeze Block Coil – (Heating or Cooling Water Coil)

1. **Shall be provided at all rooftop units with hydronic coils**

2. Coil shall be manufactured with an expansion relief header that is brazed into each and every return bend. A combination relief valve that operates by pressure and temperature, (designed to re-seat after activation) shall be affixed to the expansion relief header to protect the coil during freezing conditions. The pressure relief set point to be 200 psi and temperature relief set point to be 35 degrees. The Valve shall be situated above a drain pan.

3. The coils shall be manufactured utilizing 1/2 inch tubes (a minimum wall thickness of 0.022") or 5/8 inch tubes (minimum wall thickness of 0.020") as required to meet specified performance requirements.

4. Design Equipment: Cooney Coil.

5. Make: USA Coil "Sentry Guard"

2.10 DX COOLING COIL

A. Insulated stainless steel drip pan with corrosion resistant mastic coating with drain connections on both sides.

B. The coils shall have aluminum fins and seamless copper tubes. The fins shall have collars drawn, belled, and firmly bonded to tubes by mechanical expansion of the tubes.

C. The coil casing shall be stainless steel.

D. Suction and liquid line connections shall extend to the unit exterior.

E. Coils shall be proof-tested to 450 psig and leak-tested to 300 psig air pressure under water. After testing, the inside of the coils shall be dried, all connections shall be sealed, and the coil shall be shipped with a charge of dry nitrogen. Suction headers shall be constructed of copper tubing with connections penetrating unit casings to permit sweat connections to refrigerant lines.

F. The coils shall have equalizing vertical distributors sized according to the capacities of the coils. Coil performance data shall be certified in accordance with AHRI Standard 410.

G. Unit shall utilize R-454B refrigerant.

H. A2L refrigerant leak detection/safety controls:

1. For all units containing an A2L refrigerant - The unit shall be provided with factory mounted refrigerant leak detection/safety controls in compliance with 2022 ASHRAE 15, Standard for Refrigeration Systems.

2.11 INTERGRAL FACE AND BYPASS COIL SECTION

A. Internal face and bypass coils shall be provided as indicated on the schedule and drawings. Coils shall consist of finned heating, and bypass area, with mechanically interlocked dampers. Coils shall be constructed of 14-gage galvanized steel with fins no less than 0.010-inch thick aluminum and copper tubing a minimum 0.035-inch thick. Coils shall be certified to and bear the AHRI 410 Standard label.

B. Dampers shall be arranged to completely enclose and isolate heating elements. Coils shall include mixing baffles to minimize downstream mixing distance to 24-inches. At minimum distance, leaving air temperature shall vary no more than +/- 5 deg F from the average leaving air temperature.

C. Manufacturer shall extend coil connections on horizontal-tube coils through the unit casing wall to facilitate piping. Coil connection penetrations through unit casing shall be provided by unit manufacturer on vertical-tube coils. Installing contractor shall be responsible for providing flexible connector on return header and supply/return piping through unit casing wall.

2.12 HOT GAS REHEAT

A. Unit shall be equipped with a fully modulating hot gas reheat coil with hot gas coming from the unit condenser. Provide all required refrigerant piping and control wiring needed.

B. Hot gas reheat coil shall be a Micro Channel design. The aluminum tube shall be a micro channel design with high efficiency aluminum fins. Fins shall be brazed to the tubing for a direct bond. The capacity of the reheat coil shall allow for a 20°F temperature rise at all operating conditions.

C. The modulating hot gas reheat systems shall allow for independent control of the cooling coil leaving air temperature and the reheat coil leaving air temperature. The cooling coil and reheat coil leaving air temperature setpoints shall be adjustable through the unit controller. During the dehumidification cycle the unit shall be capable of 100% of the cooling capacity. The hot gas reheat coil shall provide discharge temperature control within +/- 2°F.

D. Each coil shall be factory leak tested with high-pressure air under water.

2.14 FILTERS

A. Provide factory-fabricated filter section of the same construction and finish as unit casings. Filter section shall have side access filter guides and access door(s) extending the full height of the casing to facilitate filter removal. Provide fixed filter blockoffs as required to prevent air bypass around filters. Blockoffs shall not need to be removed during filter replacement. Filters to be of size and quantity required to maximize filter face area for each air handling unit.

B. Filter type, MERV rating, and arrangement shall be provided as defined in project plans and schedule. Filter type shall be per Section 234000. All air handling units shall be provided with Medium Efficiency MERV-8 and High Efficiency MERV-13 filters.

C. Manufacturer shall provide one set of startup filters. Provide a complete replacement set to the Owner.

D. Each filter section shall be provided with a factory-installed, flush-mounted Dwyer 3-7/8" diaphragm actuated, dial-type differential pressure gauge piped to both sides of the filter to indicate status. Gauge shall maintain a +/- 2 percent accuracy within operating temperature limits of -20°F to 120°F. Filter sections consisting of pre- and post-filters shall have a gauge for each. Provide all accessories including adaptors, mounting panel, pressure tips, fittings, tubing, vent valves.

2.15 DAMPERS

A. All dampers shall be internally mounted. Dampers shall be premium ultra low leak and located as indicated on the schedule and plans. Blade arrangement (parallel or opposed) shall be provided as indicated on the schedule and drawings. Dampers shall be Ruskin CD60 double-skin airfoil design or equivalent for minimal air leakage and pressure drop. Leakage rate shall not exceed 3 CFM/square foot at one inch water gauge complying with ASHRAE 90.1 maximum damper leakage and shall be AMCA licensed for Class 1A. All leakage testing and pressure ratings shall be based on AMCA Standard 500-D. Manufacturer shall submit brand and model of damper(s) being furnished, if not Ruskin CD60.

2.16 ACCESS SECTIONS

A. Access sections shall be provided where indicated in the schedule and plans to allow additional access for inspection, cleaning, and maintenance of unit components. The unit shall be installed for proper access. Procedure for proper access, inspection and cleaning of the unit shall be provided in the AHU manufacturer's maintenance manual.

2.17 RETURN/DISCHARGE PLENUM SECTIONS

A. Plenums shall be provided as indicated in the schedule and plans to efficiently turn air and provide acoustical attenuation. Discharge plenum opening types and sizes shall be scaled to meet pressure drop requirements scheduled and align with duct takeoffs.

B. Discharge plenum panels shall include an acoustical liner to meet acoustical requirements. The liner shall be fabricated from stainless steel perforated material to prevent corrosion and designed to completely encapsulate fiberglass insulation. The perforation spacing and hole size shall be such as to prevent insulation breakaway, flake off, or delamination when tested at 9000 fpm, in accordance with UL 181 or ASTM C1071. Insulation material must be resistant to fungi in accordance with ASTM C1338.

2.18 EQUIPMENT PARAMETERS

A. Design: Trane Performance Climate Changer CSAA

B. Acceptable Makes: Trane, York, Daikin

3.0 PART 3 – EXECUTION

3.1 SHIPPING

A. Paper copies of the IOM shall also be shipped with each AHU.

B. The AHU manufacturer shall identify all shipments with the order number. Enough information shall be provided with each shipment to enable the Mechanical Contractor to confirm the receipt of units when they are received. For parts too small to mark individually, the AHU manufacturer shall place them in containers.

C. To protect equipment during shipment and delivery, all indoor units shall be completely stretch or shrink wrapped. Wrap shall be a minimum of 7 mil plastic. Pipe ends and pipe connection holes in the casing shall be capped or plugged prior to shipment.

D. After loading the equipment for shipment, the AHU manufacturer shall contact the shipping contact on the order and provide the name of the carrier, description of equipment, order number, shipping point, and date of shipment.

3.2 ON-SITE STORAGE

A. If equipment is to be stored for a period of time prior to installation, the Mechanical Contractor shall remove all stretch or shrink wrap from units upon receipt to prevent unit corrosion and shall either place the units in a controlled indoor environment or shall cover the units with canvas tarps and place them in a well-drained area. Covering units with plastic tarps shall not be acceptable.

3.3 FIELD EXAMINATION

A. The Contractor shall verify that the mechanical room and/or roof are ready to receive work and the opening dimensions are as indicated on the shop drawings and contract documents.

B. The Contractor shall verify that the proper power supply is available prior to starting of the fans.

3.4 INSTALLATION

A. The Contractor shall be responsible to coordinate ALL installation requirements with the Owner and the Owner's selected Mechanical Contractor to ensure that a complete installation for each unit is being provided. Coordination efforts shall include such items as unloading and hoisting requirements, field wiring requirements, field piping requirements, field ductwork requirements, requirements for assembly of field-bolted or -welded joints, and all other installation and assembly requirements.

B. All air handling units which are floor mounted shall be provided with an equipment/housekeeping pad.

C. The AHU manufacturer shall provide all screws and gaskets for joining of sections in the field.

D. The Contractor shall verify that the following items have been completed prior to scheduling the AHU manufacturer's final inspection and start up:

1. All spring-isolated components have had their shipping restraints removed and the components have been leveled.

2. On all field-joined units, that all interconnections have been completed, i.e., electrical and control wiring, piping, casing joints, bolting, welding, etc.

3. All water piping connections have been completed and hydrostatically tested and all water flow rates have been set in accordance with the capacities scheduled on the Drawings.

4. All ductwork connections have been completed and all ductwork has been pressure tested for its intended service.

5. All power wiring, including motor starters and disconnects, serving the unit has been completed.

6. All automatic temperature and safety controls have been completed.

7. All dampers are fully operational.

8. All shipping materials have been removed.

9. All (clean) filter media has been installed in the units.

10. Provide external manual vent and drain lines with hose bibb and cap at all coils.

3.5 LEVELING

A. The Mechanical Contractor shall level all unit sections in accordance with the unit manufacturer's instructions. The Mechanical Contractor shall provide and install all necessary permanent shim material to ensure individual sections and entire assembled units are level.

3.6 FINAL INSPECTION AND START UP SERVICE

A. After the Mechanical Contractor has provided all water and steam piping connections, ductwork connections, and field control wiring, and Electrical Contractor has provided all the field power wiring, the Mechanical Contractor shall inspect the installation. The Mechanical Contractor shall then perform startup of the equipment.

B. The Automatic Temperature Control (Building Direct Digital Control) Contractor shall be scheduled to be at the job site at the time of the equipment start up.

C. The Mechanical Contractor, shall perform the following tests and services and submit a report outlining the results:

1. Record date, time, and person(s) performing service.

2. Lubricate all moving parts.

3. Check all motor and starter power lugs and tighten as required.

4. Verify all electrical power connections.

5. Conduct a start up inspection per the AHU manufacturer's recommendations.

6. Record fan motor voltage and amperage readings.

7. Check fan rotation and spin wheel to verify that rotation is free and does not rub or bind.

8. Check fan for excessive vibration.

9. Check coupling for proper alignment.

10. Remove all foreign loose material in ductwork leading to and from the fan and in the fan itself.

11. Disengage all shipping fasteners on vibration isolation equipment.

12. Check safety guards to insure they are properly secured.

13. Secure all access doors to the fan, the unit and the ductwork.

14. Switch electrical supply "on" and allow fan to reach full speed.

15. Physically check each fan at start up and shut down to insure no abnormal or problem conditions exist.

16. Check entering and leaving air temperatures (dry bulb and wet bulb) and simultaneously record entering and leaving chilled water temperatures and flow, steam pressures and flow, and outside air temperature.

17. Check all control sequences.

END OF SECTION 237313

SECTION 238146 - WATER SOURCE HEAT PUMP AND ACCESSORIES

1.0 PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services as required for the complete installation designed in Contract Documents.

B. Provide installation supervision and start-up services.

1.2 SUBMITTALS

A. Heat pump units and accessories. Power and control wiring diagrams, fan curves or charts, W.P.D, dimensions, weights, options for duct connections installation and start up manuals.

2.0 PART 2 - PRODUCTS

2.1 GENERAL

A. ARI Certification per Standard 320 and UL listed. Minimum energy efficiency ratio (EER) and minimum coefficient of performance (C.O.P.) at ARI conditions shall be as per schedule. Entering water in the range of 50-90^{o}F.

B. Provide extended five year compressor warranty and extended three year warranty for all other parts of the refrigeration system.

C. Each unit shall be fully run tested at the factory. Each piece of equipment boxed separately and tagged by room number.

D. Complete assembly including acoustically lined casing, compressor, reversing valve, heat exchanger, safety controls, filters, junction box, supply, return, and condensate drain connections, hanger kits with vibration isolators.

E. Unit shall conform in all respects to the 2022 revision of ASHRAE Standard 15, independent of whether specific details are enumerated within this specification.

2.2 WATER TO WATER HEAT PUMP

A. Equipment shall be completely assembled, piped, internally wired, fully charged with R-454B, and test operated at the factory. A controls field interface terminal strip, and all safety controls shall be furnished, installed and tested by the unit manufacturer. The unit shall be rated in accordance with ISO-AHRI 13256-2.

1. The system's water inlet and outlet for the source and load side connections shall be female NPT composed of copper. Service and caution labels shall be placed on the unit in their appropriate locations.

2. Units with more than 3.91 lb of R-454B refrigerant per circuit should be installed in areas greater than or equal to the minimum room area listed on each unit's nameplate and in the IOM.

B. Cabinet for Water to Water unit

1. Unit casing shall be constructed of zinc coated, heavy gauge, galvanized steel. Access to the refrigerant and controls shall be provided through the front and side, access panels.

2. All panels shall be insulated with ½-inch thick dual density bonded glass fiber. The insulation shall meet the erosion requirements of UL 181. It shall have a flame spread of less than 25 and a smoke developed classification of less than 50 per ASTME-84 and UL 723.

3. The unit shall be installed for proper access. Procedures for proper access inspection and cleaning of the unit shall be included in the maintenance manual.

C. Compressor

1. Vibration isolation shall be provided through rubber mounting devices located underneath the compressor. Internal thermal overload protection shall be provided. Protection against excessive discharge pressure shall be provided by means of a high-pressure switch. A loss of charge shall be detected by a low-pressure safety.

D. Refrigerant Tubing, Circuit & RV for EXW

1. The refrigerant tubing shall be of 99% pure copper. This system shall be free from contaminants and conditions such as drilling fragments, dirt and oil.

2. The refrigerant circuit shall contain a thermal expansion device. Service pressure ports shall be factory supplied on the high and low pressure sides for easy refrigerant pressure or temperature testing. The reversing valve shall be a pilot operating, sliding piston type with a replaceable, encapsulated magnetic coil. The reversing valve shall be energized in the cooling cycle.

E. Water-to-Refrigerant Heat Exchangers

1. The water-to-refrigerant heat exchangers shall be of a high quality, co-axial coil for maximum heat transfer. The source-side heat exchanger shall be constructed of copper. The load-side heat exchanger shall be constructed of copper. Both heat exchangers shall be deeply fluted to enhance heat transfer and minimize fouling and scaling. The coil shall have a working pressure of 400 psig on the waterside and 600 psig on the refrigerant side.

2. The source side water-to-refrigerant heat exchanger(s), water lines, and refrigerant suction lines shall be insulated to prevent condensation at low temperatures below 60F degrees.

F. Electrical

1. The unit control box shall contain the necessary devices to allow heating and cooling operation to occur from a remote wall thermostat. These devices shall be as follows:

   a. A 24 VAC energy limiting class II 100 VA transformer

   b. A 24 VAC compressor contactor for compressor control

   c. Field control connections shall be provided for ease of hook-up to a terminal strip located in the unit's control box

   d. A lockout relay, which controls cycling of the compressor, shall be provided to protect the compressor during adverse operating conditions. This device shall be capable of reset by interrupting power to the 24 VAC control circuit. Reset may be done either at a remote thermostat or through a momentary main power interruption.

G. Factory Installed Accessories

1. A high-pressure switch shall be provided to protect the compressor against operation at refrigerant system pressure exceeding 600 psig.

2. A low pressure switch shall be provided to protect the compressor against operation at refrigerant system pressure below 40 pisg (loss of charge).

3. Freeze protection shall be provided to prevent the unit from operating at low water temperatures.

4. Discharge Line Thermostat shall be provided to protect the compressor against a high discharge temperatures in case of loss of charge or other conditions which could drive the discharge temperature higher.

H. Controls

1. The control package shall provide a 100 VA transformer with a circuit breaker. The controller shall include a lockout relay, anti-short cycle compressor protection, random start delay, brown-out protection, low pressure time delay, compressor delay on start and an open relay for ancillary controls request. Three LEDs, Light Emitting Diodes, shall also be included for diagnostics of each refrigeration circuit.

I. Warranty:

1. The unit shall be warranted by the manufacturer against defects in material and factory workmanship for one year.

2. The refrigerant circuit including motor-compressor, expansion device, all heat exchangers in contact with refrigerants, and reversing valve (less the solenoid coil) shall be warranted for that year (parts only).

3. 5-year compressor warranty standard.

J. Design Equipment: Trane EXWK

K. Make: Daikin, Trane, JCI/York.

3.0 PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide the complete installation in accordance with the manufacturer's recommendations.

1. Provide P-Trap on condensate drain.

2. Refer to "Piping Systems and Accessories" Section for cleaning and flushing of water systems. Prevent the entry of foreign material into heat pump units.

3. Do not connect heat pumps to system, until entire system is clean and flushed.

B. Provide control wiring for equipment and controls as described in this section and in the "Control Systems" Section.

3.2 INSTALLATION SUPERVISION AND START-UP

A. Provide the services of a factory authorized technician to inspect the installation of the units, wiring and piping connections prior to start-up, and at completion of the installation start-up the system.

B. Check out the entire heat pump installation including the closed circuit loop, loop water cleaning and treatment, control devices, start the system, making tests and adjustments, and put the system into satisfactory operation.

C. Provide a total of one day of instruction to the Owner. One half day for heat pump operation and one half day for the control system operation.

END OF SECTION 238146

SECTION 238210 - HYDRONIC GRAVITY HEATING EQUIPMENT

1.0 PART 1 – GENERAL

1.1 DESCRIPTION

A. Provide labor, materials, equipment and services as required for the complete installation designed in Contract Documents.

1.2 SUBMITTALS

A. Submit shop drawings on gravity heating equipment with color selection chart. Custom color selection by architect shall be accepted. Clearly indicate which equipment is being submitted.

2.0 PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. All equipment shall be free from expansion, noises and strains. Exposed parts to be cleaned and phosphate coated before prime coating or baked enameling. Finish colors as selected by architect, custom color during the submittal process. Factory-boxed and tagged by room numbers. Access doors shall be provided in cabinet at locations of valves, flow balancers and air vents. Verify at site, the space available for each piece of equipment. Top of heating unit enclosures shall be at least 1 in. below top of windowsill. Bottom of heating unit enclosures, unless otherwise called for, approximately 6 in. above floor and above the base molding. Refer to Owner's representative at once, any correction, discrepancy or suggested change in size or location. This Contractor responsible for proper location and size of recesses. Coordinate dimensions from floor to bottom of recess with other trades. Provide framing in recess and shims, if required.

B. All capacities shall be IBR approved ratings. Units shall be IBR approved as a complete assembly including element and cover.

2.2 FIN RADIATION

A. General Requirements:

1. Complete enclosure, continuous supporting channel full backplate, heating element, hangers and accessories, as specified and shown on the Contract Drawings.

2. Enclosures to run from wall-to-wall unless otherwise called. Provide necessary corner pieces, end caps, column enclosures, butt trims, wall sleeves, with access doors. Do not leave any enclosure installed without an end trim piece.

B. Heating Element:

1. Hot Water System: Seamless copper tube with non ferrous aluminum fins, 125 lbs. minimum hydrostatic test pressure. .020" tube wall thickness, minimum. .016" fin thickness, fin dimensions as scheduled.

2. Tube mechanically expanded to fin collars for permanent metal to metal contact.

3. Properly support with pitch adjustment. Silent element and pipe support. Locate a maximum of 2'-0" apart. Support shall allow for lateral movement for expansion and contraction of heating equipment.

4. Number of rows as indicated on equipment schedules.

C. Enclosures:

1. Enclosure fronts 16 gauge furniture steel.

a. Sloping top with aluminum discharge grille and shall run the continuous length of the enclosure.

b. Edges and corners rounded. Individual sections not over 6 ft. No exposed areas shall have sharp edges.

c. Mechanically fastened to wall bracket.

d. Continuous interlocking slip joint fit between adjoining covers. Finish shall match enclosure fronts along entire male and female sides.

e. Enclosure accessories shall fit tight to wall at sides, in full back plate at top and extend back and mechanically screw to wall at bottom.

f. Custom color selection by architect.

2. Support channel full backplate with top wall gasket and supports:

a. 20 gauge securely fasten to wall.

b. Enclosure front braced by internal channel braces. Minimum on either side of joint seam.

c. No sheet metal screws or other fastening devices shall be visible.

d. Provide wall brackets or stiffening supports adjacent to each joint and at least every 16 in., maximum 24" O.C.

3. Top of cover rest on backplate only and not between wall and backplate.

D. Design Equipment: Sterling JVB-ARS

E. Make: Sterling, Vulcan, Rittling.

3.0 PART 3 - EXECUTION

3.1 INSTALLATION

A. Each unit isolated with shut-off ball valves to permit servicing. Provide flow balancer for each unit as detailed. Provide trap for each unit as detailed. Contractor responsible for correct end connections and arrangements. Arrange piping accessories and valving fully accessible for servicing. Enclosures fastened to structure with screws or bolts, no nailing allowed. Fasten at 6 in. O.C.

END OF SECTION 238210

SECTION 238216 - COILS

1.0 PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services as required for the complete installation designed in Contract Documents.

1.2 SUBMITTALS

A. Submit shop drawing on coils.

2.0 PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Provide coils of proper size and rows to fit intended use and capacity as scheduled and specified. Location as shown on Plans. Designed for 125 psi. Same end or opposite end connections as required to fit installation shown on Plans. Vertical mounted coils shall have bottom drain headers. Duct mounted coils shall be equipped with flanges. Tag each coil at factory giving number and location. Coils completely drainable with auxiliary drain headers, if necessary. Minimum 1/2 in. drain and vent connections. Aluminum fins shall be a minimum of .0075 in. thick unless otherwise noted. Coils shall have brazed return "U" bends, bent tubes are not acceptable. Performance certified in accordance with ARI Standard 410.

2.2 DUCT MOUNTED HOT WATER HEATING COIL

A. Non-ferrous heating coils, 125 psi working pressure, designed to relieve expansion and contraction strains. Minimum 16 gauge galvanized casing, non-ferrous or cast iron headers, 0.035” thick copper tubes with 0.035” thick "U" bends, aluminum fins, for coils. Coils tested at 300 psig then leak tested at 200 psig with air pressure under water. Hot water heating coils, serpentine type, number rows and arrangement as called for; same end connections with vent chamber on return end and completely drainable. Provide with turbulators.

B. Refer to section below for heating hot water coils associated with a chilled water cooling coil for additional requirements.

C. Design Equipment: Trane

D. Make: Daikin, Trane, Heatcraft.

3.0 PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment in strict accordance with manufacturer's instructions and so as to be compatible with intent of the respective system performance requirements. Provide supporting ironwork and sheet metal safing to assure proper installation without any bypass air around coil.

B. Provide a stainless steel drip pan under each cooling coil section extended a minimum of 12” beyond downstream side of coil. Provide with 1-1/4” tapped drain connection pipe to nearest floor drain.

C. Provide ample space during installation to allow for the removal of the coil. Provide all necessary unions, isolation valves, flexible connectors and accessories to allow for the removal and service of the coil.

D. Provide an access door upstream of all coils for inspection. Access door shall be minimum 16 x 12.

END OF SECTION 238216

SECTION 238219 - FAN COIL UNITS

1.0 PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide labor, materials, equipment and services as required for the complete installation as shown on the Contract Drawings.

1.2 SUBMITTALS

A. Room fan coil units and accessories including coil capacities, grille type and filters.

2.0 PART 2 - PRODUCTS

2.1 GENERAL

A. Baked enamel finish of color selected from manufacturers standard colors. Each piece of equipment boxed separately and tagged by room number.

2.2 ROOM FAN COIL UNITS

A. Cabinets/Consoles:

1. 18 gauge steel removable front enclosure so that internal operating parts are accessible for service or replacement.

2. Tamperproof Cam type locks.

3. Directed flow four-way adjustable discharge grilles.

4. Isolated valve compartment.

5. Access to motor, fan assembly and filters.

6. Type as required for job conditions.

7. Return air grilles.

8. Factory installed air vent tapping.

9. Factory supplied outside air damper/fresh air inlet.

10. Insulated drip pan for coil and valve sections.

11. Insulated cabinet with material in compliance with NFPA 90A requirements.

12. Provide unit with Maxiblue Condensate Pump, 110V/1Phase. Provide with White Fascia Kit to conceal all exposed pump accessories and tubing.

B. Heating Coils:

1. Copper tubes and headers, nonferrous fins.

C. Cooling Coils:

1. Copper tubes and headers, nonferrous fins.

2. Stainless steel, insulated drain pan.

D. Motors:

1. High Static ECM Motors.

2. Built-in overload protection.

3. Resilient mountings to dissipate noise and magnetic vibration.

4. Unit mounted and wired multi-speed switch.

5. Quick detachable motor cords.

E. Filters: Provide 1" thick throwaway type, MERV 13.

F. Shall not to exceed 35 decibels, 5 ft from units.

G. Design Equipment: Trane FCD

H. Make: Carrier, Daikin, Trane.

2.3 LOW PROFILE - RECESSED TYPE

A. Arrangement:

1. Base unit designed for fully recessed wall installation.

2. Features and accessories shall be the same as room type, except for the following:

a. Base casing shall be provided in lieu of finished cabinet.

b. Remote flush mounted speed switch shall be provided.

c. Maximum unit height 10”.

d. Ducted supply and return air connections.

e. Condensate overflow detection device.

f. Factory installed condensate pump.

g. Provide unit with Maxiblue Condensate Pump, 110V/1Phase. Provide with White Fascia Kit to conceal all exposed pump accessories and tubing.

B. Design Equipment: Trane FCC – Concealed above ceiling

C. Make: Carrier, Daikin, Trane.

3.0 PART 3 - EXECUTION

3.1 GENERAL

A. Left hand or right hand piping connections for supply and return. Obtain complete instructions from unit manufacturer regarding each item and proper installation of same. Adjust motor speed.

3.2 INSTALLATION

A. In accordance with manufacturer's recommendations. Install piping within valve compartment to allow for pipe insulation. Provide drain piping. Vacuum clean inside of unit prior to operating units. Provide flexible duct connections at supply and return connections to ceiling units. Install remote speed switch for recess and ceiling units. Provide wiring.

END OF SECTION 238219

SECTION 238223 - UNIT VENTILATORS

1.0 PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services as required for the complete installation designed in Contract Documents.

1.2 SUBMITTALS

A. Unit ventilators.

1.3 ARRANGE FOR UNIT VENTILATOR MANUFACTURER TO

A. Provide Detailed Drawings of Unit Ventilator for Each Typical Room.

B. Thoroughly instruct Heating Contractor in installation of intake boxes, unit ventilator cabinets, metal shelving, etc. Upon completion, examine complete installation and certify in writing that installation is in accordance with manufacturers instructions.

C. Complete testing and start-up for each unit shall be performed by the manufacturers authorized representative.

D. Instruct Owner Representative in operation and care of unit ventilator system.

2.0 PART 2 - PRODUCTS

2.1 GENERAL

A. Equipment of one manufacturer. Each system shall include complete field installed temperature control system. Surfaces baked enamel finish, color as selected from manufacturers standard colors. Equipment boxed separately and tagged by room number.

2.2 UNIT VENTILATORS

A. CABINET

1. Cabinet Construction

   a. VUH1200

      1) The unit cabinet shall be 14ga, formed unibody construction for superior rigidity with dimensions of 33” wide by 93” high by 23” deep. The finish shall be a durable powder coat – textured finish, color chosen by the Architect from manufacturer standard colors. The cabinet shall be fully lined with 1” closed cell insulation. The return air grille shall be removable heavy duty steel. The unit shall have a draw through configuration with either an “L”-type outdoor air/return air damper assembly. For easy maintenance, access to the internal components shall be through the front of the unit.

2. Filter

   a. The filters shall be of the manufacturer’s 2” and shall have a MERV 13 filters. One spare set of filters shall be provided and shipped loose for each unit.

3. Access Panels

   a. Internal components shall be easily accessible through front access panels which shall be side hinged. The hinge shall not protrude beyond the front surface of the unit and the hinged panel shall be securely closed with two fast lead captive fasteners. The fast lead captive fasteners shall ensure a tight air seal for the access panels.

4. Drain Pan

   a. For all units with cooling coils, an stainless steel; double sloped drain pan shall be provided. The drain pan shall be insulated on the underside with ½” closed cell insulation. A 5/8” vinyl condensate line shall be provided. A running or field provided “P” trap shall be provided by the installing contractor.

5. Outdoor / Return Air Mixing Dampers

   a. The outdoor air (OA) and return air (RA) dampers shall have airfoil section extruded aluminum blades with flexible seal blade tips and jamb seals. Leakage shall not exceed 4 c.f.m. per sq. ft. at 3” W.G. differential pressure as determined by a recognized testing laboratory. A Belimo spring return damper actuator shall be supplied and installed by the unit manufacturer.

6. Condensate Pump

a. A condensate pump shall be factory installed and wired within the unit as noted on schedule.

7. Line Voltage

a. All internal line voltage wiring shall be by the unit manufacturer with a single power connection point. A single suitably rated unfused service disconnect switch shall be factory installed within the unit. Voltages include 115V/60 Hz 1 phase, 208-230 V/60Hz 1 or 3 phase, 277V/60Hz 1 phase or 480 V/60Hz/3 phase + Neutral. A suitably rated remote circuit breaker shall be provided and installed by the electrical contractor.

8. Control Panel

a. A control panel (without the controller) shall be factory provided and installed. It shall be located behind the front access panel for easy maintenance and service and shall include a 40 VA control transformer with the required contactors, relays and circuit protection.

B. Motors

1. Supply Air Fans

a. The internal supply fan assembly shall include one (two for VUD2000) direct drive electronically commutated motors (ECM) and blowers mounted on rubber isolation grommets. The ECM motors shall be programmed for high efficiency and low audible sound. The motors shall consist of a brushless, permanently lubricated ball bearing construction for maintenance free operation.

C. Coils

1. Hot Water Heating Coil

a. A hot water heating coil shall be installed inside of the unit. The coil shall have 1/2” OD copper tubes of minimum thickness 0.016” and shall have aluminum fins. The coil supply and return headers shall be copper pipe sized to suit water flow, no larger than 1” OD and stubbed out for sweat connection. The coil shall be factory pressure tested at not less than 350 p.s.i. A manual air vent and drain cock shall be factory installed. The coil capacity shall be as shown in the equipment schedule. The coil shall be installed in Preheat position.

2. Face and Bypass:

a. The unit ventilator shall be equipped with face and bypass dampers. The dampers shall have airfoil section extruded aluminum blades with flexible seal blade tips and jamb seals. Leakage shall not exceed 4 c.f.m. per sq. ft. at 3" W.G. differential pressure as determined by a recognized testing laboratory. The dampers shall be provided with a fully modulating Belimo non-spring return actuator.

3. Chilled Water Cooling Coil

a. A chilled water cooling coil shall be installed inside of the unit. The coil shall have 1/2" OD copper tubes of minimum thickness 0.016" and shall have aluminum fins. The coil supply and return headers shall be copper pipe sized to suit water flow, no larger than 1" OD and stubbed out for sweat connection. The coil shall be factory pressure tested at not less than 350 p.s.i. A manual air vent and drain cock shall be factory installed. The coil capacity shall be as shown in the equipment schedule.

D. Piping Options

1. Piping options shall be fitted inside the unit by the factory and insulated to prevent sweating. All piping components should be accessible from the front of the unit.

2. Water control valves shall be supplied and installed by mechanical contractor in the field, External Of The Unit.

E. Controls

1. DDC Control:

a. The contractor shall supply and install in field the unit controller, temperature sensors, current sensor, and all other control components as described in the sequence of operation. All factory installed wiring shall be connected to a terminal strip within the unit.

F. Unit Accessories

1. Outdoor Air Rear Plenum

a. Where shown on the plans the unit manufacturer shall provide an outdoor air plenum assembly and shall be color matched to the unit. The plenum shall be lined with glass fiber insulation and shall be sized to suit ceiling height. Refer to schedule for plenum depth.

2. Top Extension

a. The unit manufacturer shall provide a color matched 36” top extension for the cabinet, size to suit the ceiling height. The top extension shall be custom made at the factory to allow for a two inch protrusion through the suspended ceiling. Exposed screws on the exterior face of the top extension are not acceptable.

3. Condensate Pump

a. All unit ventilators with cooling coil shall be factory provided with a Little Giant VCMX condensate pump as noted on schedule. Pump shall be installed internal to the unit ventilator as not to interfere with unit performance, operation or air flow. The condensate pump shall wired into the unit ventilator control enclosure for a power source.

G. Design Equipment: Temspec

H. Make: School Air, System Air, Temspec

3.0 PART 3 - EXECUTION

3.1 CONTRACTOR'S RESPONSIBILITY

A. This contractor responsible to:

1. Order correct end connections for supply, return, electric and dampers.

2. Obtain complete instructions from unit manufacturer regarding each item and proper installation of same.

3. Make certain and guarantee that airtight sealing is made between air opening and unit back. Skim coat wall with plaster to provide a smooth surface for airtight seal.

4. Make installation water and weathertight; guarantee same.

5. Check building construction to see that same will allow proper installation. If not satisfactory, notify Architects.

6. Obtain correct end roughing for electric. Coordinate with Division 26, Electric.

7. Establish exact location of intake boxes.

3.2 INSTALLATION

A. Fasten securely to wall and floor with expansion bolts.

1. With tight fitting neoprene gasket around air intake.

2. Provide felt or sponge rubber pad between unit and floor.

3. Shim and align unit ventilators.

4. Arrange valving and piping and accessories accessible for servicing.

5. Provide extra thick compressible insulation on back of unit to insure no leakage of outside air beyond unit intake.

B. This Contractor responsible for proper setting and location of units and intake boxes, grilles and sleeves.

1. Correct, as part of Contract, any misplaced or improperly set units or intake boxes.

C. Protect units from damage until final acceptance:

1. Restore or replace any damaged part.

END OF SECTION 238223

SECTION 238239 - UNIT HEATERS AND CABINET UNIT HEATERS (HYDRONIC)

1.0 PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide labor, materials, equipment and services as required for the complete installation and related work as shown on the Contract Documents.

1.2 SUBMITTALS

A. Unit heaters and cabinet unit heaters.

B. Wiring diagrams, performance data and electrical requirements.

C. Color options and samples for review.

2.0 PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Free from expansion and contraction noises and strains. Fan speed shown on Schedule shall not be exceeded. Each piece of equipment factory-boxed and tagged by room number. Cabinet unit heaters and unit heaters shall have baked enamel finish with color selected by the Architect from manufacturer's standard colors. Rating in accordance with standard test codes adopted jointly by IUGA and ASHRAE.

2.2 UNIT HEATERS

A. General:

1. Ceiling suspended, with 18 gauge panels.

2. Access for servicing the heating element, motors, and controls.

3. Horizontal discharge units with adjustable horizontal and/or vertical outlet vanes.

4. Vertical units with adjustable outlet louvers or diffusers.

5. Unit shall have textured grey epoxy powder coat paint finish.

B. Fan And Motor:

1. Statically and dynamically balanced.

2. Motor shall be totally enclosed and designed for continuous operation. Lubrication shall be sealed-in, permanent type.

3. Low voltage thermostat.

4. Unit mounted disconnect switch.

C. Heating Element (Hydronic):

1. 0.028” thick copper tubing serpentine coil, 0.01” thick aluminum fins with side connections to fit headroom requirements.

2. Aquastat on return side to prevent fan operation when heat is not available.

D. Hydronic:

1. Design Equipment: Rittling RH - Series.

2. Acceptable Makes: Sterling, Trane, Rittling.

2.3 CABINET UNIT HEATERS

A. General:

1. Rough-in dimensions must not exceed those of design equipment.

B. Cabinet:

1. Front and exposed parts, 16 gauge furniture steel, all others, 20 gauge steel.

2. Fronts shall be hinged and removable for access to interior parts.

3. Front panels shall be provided with allen-head quarter turn fasteners.

4. Recessed or semi-recessed equipment to have four-side overlap, trim strips not acceptable.

5. Recessed units shall be provided with face supply and return louvers.

6. Exposed units shall be provided with face supply and end return louvers.

C. Fan And Motor:

1. Fans, forward curved, centrifugal type, direct drive from motor shafts.

2. Driven by totally enclosed motor with overload protection and lifetime lubrication.

a. Integral manual motor starter with disconnect switch.

3. Shall be quiet in operation, not to exceed 45 db measured 5 ft. away, at high speed.

4. Three speed accessible fan selector switch.

5. Low voltage thermostat.

6. Permanent filter.

D. Heating Element (Hydronic):

1. Nonferrous construction, copper tube, aluminum fins.

2. Multipass serpentine design for high temperature drop.

3. Aquastat on return side to prevent operation when heat is not available.

E. Hydronic:

1. Design Equipment: Rittling RC/W-420

2. Acceptable Makes: Sterling, Trane, Rittling.

3.0 PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

A. Provide equipment in accordance with manufacturer's printed instructions. Report untrue walls before installation. Report cases where clearance below suspended heaters is less than 7-1/2 ft. Provide clearance for piping and conduit. Support units independent of piping. Support units from building structure, with screws or bolts, no nailing allowed. Be responsible for proper location and size of recesses. Coordinate installation of recessed or semi-recessed equipment in recesses. Provide framing in recess and shims. Use sponge rubber gasket air-seal between front enclosure and wall.

3.2 INSTALLATION - HYDRONIC

A. Provide valves and accessories and arrange to permit servicing. Coordinate correct end connections and coil arrangements.

END OF SECTION 238239

SECTION 260010 - BASIC ELECTRICAL REQUIREMENTS

1.0 PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All drawings and general provisions of Contract, including all General and Supplementary Conditions, Division 1 Specification Sections, and Instructions to Bidders apply to this section and all other sections of Division 26, 27, & 28.

B. Section 019113 – Commissioning Requirements

1.2 REGULATIONS AND CODE COMPLIANCE

A. All work and materials shall conform to and be installed, inspected and tested in accordance with the governing rules and regulations of federal, state and local governmental agencies having jurisdiction. In the event of conflict between these contract documents and the governing rules, regulation, and codes.

B. The following is a list of codes and standards that will apply to this project:

1. 2020 Building Code of New York State (BCNYS)
2. 2020 Existing Building Code of New York State (EBCNYS)
3. 2020 Fire Code of New York State (FCNYS)
4. 2020 Energy Conservation Construction Code of New York State (ECCCNYS)
5. New York State Department of Labor Rules and Regulations
6. 2017 National Electrical Code, NFPA 70
7. Electrical Safety Requirements, NFPA 70E
8. 2016 National Fire Alarm Code, NFPA 72
9. New York State Education Department – Manual of Planning Standards
10. Federal Occupational Safety and Health Act - OSHA.
11. Factory Mutual or other Insurance Carrier.

1.3 LICENSING & PERMITS

A. The Contractor shall hold all necessary licenses to perform the scope of work at the project location.

B. Provide certificate of inspection from a licensed electrical inspection agency for all electrical work prior to acceptance of each phase.

C. Apply for and obtain all required permits and inspections, include costs for all fees and charges within bid. Provide third party inspection of all electrical work by a certified inspection agency or approved professional.

D. Refer to General Conditions of the Contract for additional requirements.

1.4 GLOSSARY

ACI	American Concrete Institute
ADA	American Disabilities Act
AGCA	Associated General Contractors of America, Inc.
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
ASTM	American Society for Testing Materials
AWSC	American Welding Society Code
FM	Factory Mutual Insurance Company
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Standards Organization
NEC	National Electrical Code
NEMA	National Electrical Manufacturers' Association
NESC	National Electrical Safety Code
NFPA	National Fire Protection Association
NYS/DEC	New York State Department of Environmental Conservation
NYS/UFBC	New York State Uniform Fire Prevention and Building Code
OSHA	Occupational Safety and Health Administration
UFPO	Underground Facilities Protective Organization
UL	Underwriter's Laboratories, Inc.

1.5 DEFINITIONS

Approved / Approval	Written permission to use a material or system.
As Called For	Materials, equipment including the execution specified/shown in the contract documents.
Code Requirements	Minimum requirements.
Concealed	Work installed in pipe and duct shafts, chases or recesses, inside walls, above ceilings, in slabs or below grade.
Design Equipment	Refer to the article, BASIS OF DESIGN.
Design Make	Refer to the article, BASIS OF DESIGN.
Equal or Equivalent	Equally acceptable as determined by Owner’s Representative
Exposed	Work not identified as concealed.
Final Acceptance	Owner acceptance of the project from Contractor upon certification by Owner's Representative.
Furnish	Supply and deliver to installation location.
Furnished by Others	Receive delivery at job site or where called for and install.
Inspection	Visual observations by Owner's site Representative.
Install	Mount and connect equipment and associated materials ready for use.
Labeled	Refers to classification by a standards agency.
Make	Refer to the article, BASIS OF DESIGN.

Or Approved Equal	Approved equal or equivalent as determined by Owner's Representative.
Owner's Representative	The Prime Professional
Prime Professional	Architect or Engineer having a contract directly with the Owner for professional services.
Provide	Furnish, install and connect ready for use.
Relocate	Disassemble, disconnect, and transport equipment to new locations, then clean, test, and install ready for use.
Replace	Remove and provide new item.
Review	A general contractual conformance check of specified products.
Rough-in	Pipe, duct, conduit, equipment layout and installation.
Satisfactory	As specified in contract documents.
Site Representative	Construction Manager or Owner's Inspector at the work site.

Refer to General Conditions of the Contract for additional definitions.

1.6 BASIS OF DESIGN

A. The contract documents are prepared on basis of one manufacturer as "design equipment," even though other manufacturers' names are listed as acceptable makes. If Contractor elects to use one of the listed makes other than "design equipment," submit detailed drawings, indicating proposed installation of equipment. Show maintenance clearances, service removal space required, and other pertinent revisions to the design arrangement. Contractor shall provide changes in the work of other trades, at no increase in any contract. Provide larger electrical feeders, circuit breakers, equipment, additional control devices and other miscellaneous equipment required for proper operation, and assume responsibility for proper location of rough-in and connections by other trades. Remove and replace door frames, access doors, walls ceilings or floors required to install other than design make equipment. If revised arrangement submittal is rejected, revise and resubmit specified "design equipment" item which conforms to contract documents.

1.7 INTENT OF DRAWINGS

A. The drawings are diagrammatic, unless detailed dimensioned drawings are included. Drawings show approximate locations of equipment, fixtures, panelboards, conduits, and wiring devices. Exact locations are subject to the approval of the Owner's Representative.

B. The general run of electrical feeders, branch circuits, and conduits, indicated on the drawings, is not intended to be the exact routing. Circuit designations, in the form of "Home Runs" on branches, indicate the designation of the branch circuit, the size and the quantity of branch circuit conductors, and the panelboard or interconnection box from which the branch circuit is served.

C. In the event of conflict between the drawings and specifications, or discrepancies within either, this shall be brought to the attention of the Engineer for resolution prior to the submission of bids. In the event that the contractor fails to note these discrepancies prior to submission of bids or in writing with the bid submission, the Engineer shall resolve the discrepancy such that the design intent is provided. The contractor shall provide all labor, materials, and equipment to correct the installation deficiencies as defined by the Engineer.

1.8 QUALITY ASSURANCE

A. Manufactures of equipment shall be firms regularly engaged in the production of factory fabricated systems and equipment whose products have been in satisfactory use in similar service for not less than three (3) years.

B. Suppliers of equipment must have factory trained and authorized personnel for the service of all equipment provided.

2.0 PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

A. The Materials, products and equipment described in the Bidding Documents establish a standard of required quality, functions, dimensions and appearance that must be met by any proposed substitution.

B. Proposed substitutions must be submitted to the Architect/Engineer a minimum of ten (10) days prior to the date for receipt of Bids. Each request shall include the name of the proposed material equipment being substituted, cut sheets, installation drawings, performance and test data and warranties. At that time the equipment or will be evaluated and if determined to be acceptable an Addendum will be issued to all bidders.

C. Requests for substitution shall be made only by a Bidder. Requests for substitution from sales representatives, vendors or suppliers are not acceptable and will not be considered.

2.2 MATERIALS

A. All materials, unless otherwise specified, shall be new and be the standard products of the manufacturer. Used equipment or damaged material will be rejected.

B. The listing of a manufacturer as “acceptable” does not indicate acceptance of a standard or catalogued item of equipment. All equipment and systems must conform to the Specifications.

2.3 U.L. LISTING

A. Equipment shall bear the Underwriter’s Laboratories (UL), or other approved agency listing label. This listing requirement applies to the entire assembly. Any modifications to equipment to suit the intent of the specifications shall be performed in accordance with the National Electric Code and listed by U.L.

2.4 SHOP DRAWINGS/PRODUCT DATA/SAMPLES

A. Submit Shop Drawings on all items of equipment and materials to be furnished and installed.

B. Submission of Shop Drawings and samples shall be accompanied by a transmittal letter, stating name of project and contractor, number of drawings, titles, and other pertinent data called for in individual sections. Refer to applicable Division 01 Section(s) for additional information and requirements.

C. All products specified in an individual Division 26, 27, and 28 specification sections shall be submitted at the same time and each Division Specification section shall have its own submittal. Number each submittal and do not combine multiple specification sections into a single submittal.

D. Shop Drawings Shall Be Dated and Contain:

1. Name of project

2. Name of prime professional;

3. Name of prime contractor;

4. Associated Specification Section, description or names of equipment, materials and items; and complete identification of locations at which materials or equipment are to be installed.

5. Incomplete submittals will not be accepted.

6. Indicate deviations from contract requirements on Letter of Transmittal.

E. Corrections or comments made on the Shop Drawings during the review do not relieve Contractor from compliance with requirements of the drawings and specifications.

F. The Contractor is responsible for confirming and correcting all quantities; checking electrical characteristics and dimensions; selecting fabrication processes and techniques of construction; coordinating his work with that of all other trades; and performing his work in a safe and satisfactory manner.

3.0 PART 3 - EXECUTION

3.1 COORDINATION DRAWINGS

A. Before construction work commences, Contractors for all trades shall submit Coordination Drawings in the form of color-coded paper drawings or electronic files (.dwg or .rvt) not less than 3/8" = 1'-0" scale. Coordination Drawings are required throughout all areas for all trades. These drawings shall identify and show resolutions of trade conflicts. Mechanical Equipment Rooms shall be drawn early in the Coordination Drawing process, simultaneous with all other congested areas. Prepare Coordination Drawings As Follows:

1. HVAC Contract will prepare the base plan Coordination Drawings showing all ductwork and all pertinent piping and equipment. These drawings may be AutoCAD or Revit format of the required ductwork Shop Drawings. The drawings shall be coordinated with cable tray, lighting fixtures, sprinklers, air diffusers, other ceiling mounted items, ceiling heights, structural work, maintenance clearances, electric code clearance, reflected ceiling plans, and other contract requirements. Re-position proposed locations of work after coordination drawing review by the Construction Manager. Provide adjustments to exact size, location and offsets of ducts, pipes, conduit, etc., to achieve reasonable appearance objectives. Provide these adjustments as part of Base Bid Contracts. Minor revisions need not be redrawn.

2. HVAC Contract will provide AutoCAD or Revit files and prints and submit the base plan to all major trades' Contractors.

3. Electrical, Plumbing and Fire Protection Contracts will draft location of piping, raceways, cable trays, light fixtures and equipment on the base plan, such that a complete coordination of all trades is represented and areas of conflict and recommended resolutions are noted.

4. Do not install any equipment, equipment foundations, raceways, cable tray, lighting or cabling until Coordination Drawings have been approved. Failure to receive approval prior to installation of the aforementioned items, will put the risk on the contractor to remove and reinstall at the engineer’s discretion. Additional time spent by the engineer in the field reviewing construction progress due to not receiving coordination drawings prior, will be considered an additional service by the consultant, which shall be paid by the contractor and deducted from any moneys owed to the contractor. The consultant’s hourly rate will apply.

3.2 ELECTRONIC CAD DRAWING FILES

A. The Engineer may provide the Contractor with AutoCAD (.dwg) or Revit (.rvt) format files for this project with the understanding that these CAD files shall be used for reference purposes only, and not as shop drawings or as-built documents. It is the Contractors’ responsibility to provide detailed, coordinated shop drawings and documentation prior to installation. The purpose of the Contractors’ coordination shop drawings is to account for all trades and field conditions and identify any conflicts that shall be resolved prior to installation.

B. Any additional cost for changes due to conflicts as a result of the Contractors' failure to provide properly coordinated documents will be the responsibility of the Contractors and not of the Engineer.

C. A request must be made in writing to the Engineer with the requested individual files. The contractor will then be sent a CAD Release Form and must sign the form to obtain electronic drawings.

3.3 ROUGH-IN

A. Due to small scale of Drawings, it is not possible to indicate all offsets, fittings, changes in elevation, etc. Verify final locations for rough-ins with field measurements and with the equipment being connected. Verify exact location and elevations at work site prior to any rough-in work. **DO NOT SCALE PLANS**. If field conditions, details, changes in equipment or shop drawing information require a significant change to the original documents, contact the owners representative for approval before proceeding.

B. All equipment locations shall be coordinated with other trades to eliminate interference with required clearances for equipment maintenance and inspections.

1. Coordinate work with other trades and determine exact routing of all duct, pipe, conduit, etc., before fabrication and installation. Coordinate with Architectural Drawings. Verify with Owner's Representative exact location of all equipment in finished areas, such as thermostat, fixture and switch mounting heights, and equipment mounting heights. Coordinate all work with the architectural reflected ceiling plans and/or existing Architecture. Mechanical and electrical drawings show design arrangement only for diffusers, grilles, registers, air terminals, lighting fixtures, sprinklers, speakers and other items. Do not rough-in contract work without reflected ceiling location plans.

2. Before rough-in for equipment furnished by Owner or in other contracts, obtain from Architect and other Contractors, approved rough-in drawings giving exact location for each piece of equipment. Do not "rough-in" services without final layout drawings approved for construction. Cooperate with other trades to insure proper location and size of connections to insure proper functioning of all systems and equipment. Obtain written authorization from the Owners representative or other contractor for any "rough-ins" that, due to project schedule, are required before approved coordination drawings are available. Any work installed without written authorization or approved coordination drawings, causing a conflict will be relocated by the electrical contractor at no expense to the Owner.

3. For equipment and connections provided in this contract, prepare rough-in drawings as follows:

a. Existing equipment being relocated: Measure the existing equipment and prepare drawings for installation in new location.

b. New equipment: Obtain equipment rough-in drawings and dimensions, then prepare rough-in drawings.

4. Where more than one trade is involved in an area, space or chase, all shall cooperate and install their own work to utilize the space equally between them in proportion to their individual requirements. In general, ductwork shall be given preference except where grading of piping becomes a problem, followed by piping then electrical wiring. If, after installation of any equipment, piping, ducts, conduit, and boxes, it is determined that ample maintenance and passage space has not been provided, rearrange work and/or furnish other equipment as required for ample maintenance space. Any changes in the size or location of the material or equipment supplied, which may be necessary in order to meet field conditions or in order to avoid conflicts between trades, shall be brought to the immediate attention of the Owner's Representative and approval received before such alterations are made.

C. Provide easy, safe, and code mandated clearances at controllers, motor starters, valve access, and other equipment requiring maintenance and operation. Contractor shall relocate existing work in the way of new construction. VISIT SITE BEFORE BIDDING TO DETERMINE SCOPE OF WORK. Provide new materials, including new piping and insulation for relocated work.

D. All equipment requiring service and/or access shall be provided adequate clearances for this purpose. Any clearances described in manufacturer's information, code requirements, etc. shall be taken into account in determining final rough-in positions. Reasonable access for maintenance and service shall be maintained.

3.4 EXISTING SYSTEMS AND CONDITIONS

A. Prior to beginning work inspect and test all existing electrical systems that will be affected by the work in this contract. Provide a report to the Owner indicating any problems or defects found. If no problems or system defects are submitted, the contractor shall be responsible for correcting problems found at the completion of the project that are determined to be caused by the work of this contract.

B. Inspect the entire work area for defects in the existing construction such as scratches, holes etc. Submit a complete list and photographs of existing damage, to the owner prior to beginning work. If existing damage is not documented the contractor shall repair all damage to like new condition, that is determined to have been caused by the work in this contract.

3.5 ELECTRICAL INSTALLATIONS

A. All installations shall comply with the following requirements:

1. Coordinate electrical systems, equipment, and materials installation with other building components. Be responsible for any changes in openings and locations necessitated by the equipment installed.

2. The architect shall control the placement of all wall and ceiling mounted electrical equipment and devices in all rooms with the exception of mechanical and electrical equipment rooms. When drawing details are not available, consult with the Architects representative for actual location.

3. Verify all dimensions with field measurements.

4. Arrange for all chases, slots and openings in other building components that are not indicated on drawings, to allow for electrical installations.

5. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.

6. Coordinate ordering and installation of all equipment with long lead times or having a major impact on work by other trades so as not to delay the job or impact the construction schedule. Pay close attention to equipment that must be installed prior to building enclosure.

7. Where mounting heights are not detailed or dimensioned, install systems, materials and equipment to provide the maximum headroom possible.

8. Install systems, materials and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer the conflict to the Architect.

9. Store Materials on dry base, at least 6" above-ground or floor. Store so as not to interfere with other work or obstruct access to buildings or facilities. Provide waterproof/windproof covering. Remove and provide special storage for items subject to moisture damage. Protect against theft or damage from any cause. Replace items stolen or damaged, at no cost to Owner.

10. Set all equipment to accurate line and grade, level all equipment and align all equipment components.

11. All tolerances in alignment and leveling, and the quality of workmanship for each stage of work shall be as required by the manufacturer and subject to approval by the owners representative.

12. All finished equipment surfaces damaged during construction shall be brought to “as new” condition by touch up or repainting. Any rust shall be removed and primed prior to repainting.

13. Workmanship shall be as called for in the “Standard of Installation” published by the National Electrical Contractors Association (NECA).

14. Provide all scaffolding, rigging, hoisting and services necessary for erection and delivery of equipment and apparatus furnished into the premises. These items shall be removed from premises when no longer required.

15. No electrical equipment shall be hidden or covered up prior to inspection by the owners representative. All work that is determined to be unsatisfactory shall be corrected immediately.

16. All electrical work shall be installed level and plumb, parallel and perpendicular to other building systems and components.

17. Conceal all contract work above ceilings and in walls, below slabs, and elsewhere throughout building. If concealment is impossible or impractical, notify Owner's Representative before starting that part of the work and install only after his approval. In areas with no ceilings, install only after Owner's Representative reviews and comments on arrangement and appearance.

18. Install access panel or door where units are concealed behind finished surfaces.

3.6 PAINTING

A. This Contract includes the following :

1. Painting for all cut and patch work performed as part of Division 26, 27, and 28 contract.

2. Painting required for touch-up of surfaces damaged due to the installation of electrical work.

3. Painting as required to repair finish of equipment furnished.

4. Painting of all surface mounted raceways in finished areas.

3.7 ELECTRICAL EQUIPMENT CONNECTIONS

A. Provide complete power connections to all electrical equipment. Provide control connections to equipment where indicated on the drawings. Provide a disconnect switch ahead of each piece of equipment receiving an electrical connection in accordance with the latest version of the National Electrical Code . Ground all equipment in accordance with the latest version of the National Electrical Code.

B. Provide all power wiring, electric equipment, control wiring, switches, lights, receptacles, and connections as required for proper equipment operation of Owner-Furnished Equipment and Equipment furnished by other contracts,

C. Refer to Manufacturer's drawings/specifications for requirements of special equipment. Verify connection requirements before bidding and confirm prior to rough-in.

3.8 CLEANING

A. After all tests are made and installations completed satisfactorily:

1. Thoroughly clean entire installation, both exposed surfaces and interiors.

2. Remove all debris caused by work.

3. Remove tools, surplus, materials, when work is finally accepted.

3.9 TEMPORARY FACILITIES

A. Refer to the Standard General Conditions of the Contract for Construction and Supplemental General Conditions.

3.10 CONTINUITY OF SERVICES

A. The building will be in use during construction operations. Maintain existing systems in operation within all rooms of building at all times. Refer to "General Conditions of the Contract for Construction" for temporary facilities for additional contract requirements. Schedules for various phases of contract work shall be coordinated with all other trades and with Owner's Representative. Provide, as part of contract, temporary mechanical and electrical connections and relocation as required to accomplish the above. Obtain approval in writing as to date, time, and location for shut-down of existing mechanical/electrical facilities or services.

3.11 START UP AND OWNER INSTRUCTIONS

A. Before acceptance of the work, furnish necessary skilled labor to operate all systems by seasons. Instruct the Owners designated personnel on the proper operation and maintenance of systems and equipment. Obtain written acknowledgment from person instructed prior to acceptance repeat the instructions if asked to do so. Contractor is fully responsible for systems until acceptance, even though operated by Owner's personnel, unless otherwise agreed in writing. Provide, operating, maintenance and starting precautions and procedures to be followed by the Owner for operating systems and equipment. Mount the instruction in clear plastic holder on or adjacent to the equipment.

B. Where supervision by a manufacturer is called for, provide manufacturer’s certified technician or engineer to supervise the startup, testing and adjustment of the equipment or system. Where two or more manufacturers are involved (i.e., variable frequency drive and air handling unit) both manufacturer’s shall be present at start up. The manufacturer shall provide a written report detailing the testing and start-up including problems that occurred and their method of resolution.

C. Refer to Division 01 Specifications for additional startup and Contract Closeout requirements.

3.12 OPERATION AND MAINTENANCE MANUALS

A. Provide Operation and Maintenance Manuals. Include one copy each of approved Shop Drawings, wiring diagrams, piping diagrams, spare parts lists, as-built drawings and manufacturer's instructions. Include typewritten instructions, describing equipment, starting/operating procedures, emergency operating instructions, seasonal changeover, freeze protection, precautions and recommended maintenance procedures. Include name, address, and telephone number of supplier manufacturer Representative and service agency for all major equipment items.

B. Bind above items in a three-ring binder with name of project on the cover. Deliver to Owner's Representative before request for acceptance. Provide copy of O&M manual in electronic format on media acceptable to the Owner. All documents shall be in searchable PDF format, with the exception of record drawings with shall be provided in AutoCAD compatible drawing format.

3.13 RECORD DOCUMENTS

A. In addition to all requirements elsewhere in the Contract Documents, prepare and provide record documents of the as-constructed work which meets the following standards:

1. Document the routing major raceway systems, location of control devices, branch circuit numbers for all devices and equipment and fuse and circuit breaker sizes for major equipment and branch circuit home runs.

2. Provide stamp on each drawings including: Company Name, Date and "Record Drawings"

3. Refer to each Division 26, 27 and 28 section for additional items to be included in the record drawings.

4. Incorporate all field changes, change orders, and other modifications into the final Record Drawings.

5. Record Drawings shall contain all corrections from construction documents to as-built conditions and shall be submitted for review and approval.

6. Drawing Format:

a. Documents shall be provided in PDF format, or where fully developed in CAD, in AutoCAD compatible file format. Submittal media shall be as acceptable to the Owner and Engineer.

b. Drawing scale shall not be less than 3/8" = 1'-0".

3.14 REMOVALS

A. Where existing equipment removals are called for, submit complete list to Owner's Representative. All items that Owner wishes to retain that do not contain asbestos or PCB Material shall be delivered to location directed by Owner. Items that Owner does not wish to retain shall be removed from site and legally disposed of. Removal and disposal of material containing asbestos and/or PCB's shall be in accordance with Federal, State and Local law requirements. Where equipment is called for to be relocated. Contractor shall carefully remove, clean and recondition, then reinstall. Remove all abandoned piping, wiring, equipment, lighting, ductwork, tubing, supports, fixtures, etc. Visit each room, crawl spaces and roofs to determine total Scope of Work.

B. Completely remove all piping, conduit, controls, and other devices associated with the equipment not to be reused in the new work. This includes all equipment, conduit, junction boxes, devices, panels, and all hangers, including the top connection and any fastenings to building structural systems. Patch, paint and seal all removals, openings and other penetrations in roof, walls, ceilings, floors, in an approved manner and in accordance with plans and specifications where specifically covered. Structural integrity of the building system shall be maintained. Reference shall also be made to the architectural, structural, mechanical, site, and electrical drawings and specifications for additional facilities to be demolished or handled.

3.15 ASBESTOS RECOGNITION AND PRECAUTIONS

A. The contractor shall be responsible for coordination of all required removal work, coring, cutting and patching with the owners asbestos management plan. Prior to performing such work identify areas containing asbestos. Notify the Owner so that they may make arrangements for abatement and/or containment prior to work proceeding. The contractor shall be responsible for cleaning all areas where asbestos is released due to the failure to coordinate with the asbestos management plan. Refer to Division 1 sections for further requirements.

B. The disturbance or dislocation of asbestos-containing materials causes asbestos fibers to be released into the building's atmosphere, thereby creating a health hazard to workmen and building occupants. Consistent with Industrial Code Rule 56 and the content of recognized asbestos-control work, the Contractor shall apprise all of his workers, supervisory personnel, subcontractors, Owner and Consultants who will be at the job site of the seriousness of the hazard and of proper safeguards and work procedures which must be followed, as described in New York State Department of Labor Industrial Code Rule 56.

C. Refer to Division 2 sections for further requirements.

3.16 ADDITIONAL ENGINEERING SERVICES

A. In the event the Consultant is required to provide additional engineering services as a result of substitution of equivalent materials or equipment by the Contractor, or changes by the Contractor in dimension, weight, power requirements, etc., of the equipment and accessories furnished, or if the Consultant is required to examine and evaluate any changes proposed by the Contractor for the convenience of the Contractor, then the Consultant's hourly rate and expenses in connection with such additional services shall be paid by the Contractor and shall be deducted from any moneys owed to the Contractor.

B. In the event the Consultant is required to provide additional engineering services as a result of Contractor's errors, omissions or failure to conform to the requirements of the Contract Documents, or if the Consultant is required to examine and evaluate any changes proposed by the Contractor solely for the convenience of the Contractor, then the Consultant's hourly rate and expenses in connection with such additional services shall be paid by the Contractor and shall be deducted from any moneys owed to the Contractor.

C. In the event the Consultant is required to initiate design changes due to failure of the contractor to properly coordinate with the construction schedule, and / or other trades, then the Consultant's hourly rate and expenses in connection with such additional services shall be paid by the Contractor and shall be deducted from any moneys owned to the Contractor.

3.17 SALVAGEABLE MATERIALS

A. Salvageable materials will be reviewed and identified by the owner. Instruction shall be given to the Contractor whether the Owner will remove salvageable materials, or whether contractor is to remove and deliver salvageable materials to a pre-designated site.

END OF SECTION 260010

SECTION 260100 - BASIC MATERIALS AND METHODS

1.0 PART 1 - GENERAL

1.1 SCOPE

A. Minimum composition requirements and/or installation methods for the following materials and work are included in this section:

1. Miscellaneous Supports
2. Fire Stopping
3. Boxes and Cabinets
4. Equipment Pads, Bases and Supporting Devices
5. Identification
6. Arc Flash Hazard Warning Labels

1.2 SUBMITTALS

A. Product data for:

1. Boxes and Cabinets
2. Fire Stopping Materials
3. Arc Flash Hazard Warning Labels

1.3 QUALITY ASSURANCE

A. The contractor shall engage the services of a qualified installer for the installation and application of joint sealers, flashing, access panels, and cutting and patching.

B. All work shall be done in a neat and workmanlike manner. All methods of construction, details of workmanship, that are not specifically described or indicated in the contract documents, shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

C. Materials specified herein shall comply with the applicable requirements of :

1. The following Articles of the National Electric Code (NFPA 70)

a. 314 - Outlet, Device, Pull and Junction Boxes, Conduit bodies and fittings

b. 312 - Cabinets, Cutout Boxes and Meter socket Enclosures

2.0 PART 2 - PRODUCTS

2.1 MISCELLANEOUS SUPPORTS

A. Metal bars, plates, tubing, etc. shall conform ASTM standards:

1. Steel plates, shapes, bars, and grating - ASTM A 36
2. Cold-Formed Steel Tubing - ASTM A 500
3. Hot - Rolled Steel Tubing - ASTM A 501
4. Steel Pipe - ASTM A 53, Schedule 40, welded

B. Metal Fasteners shall be Zinc-coated (type, grade and class as required)

2.2 FIRE STOPPING

A. Fire-stopping for Openings Through Fire and Smoke Rated Walls and Floor Assemblies shall be listed or classified by an approved independent testing laboratory for "Through-Penetration Fire-Stop Systems". The system shall meet the requirements of "Fire Tests of Through-Penetration Fire-Stops" designated ASTM E814.

B. Acceptable Manufacturers:

1. Dow Corning Fire-Stop System Foams and Sealants
2. Nelson Electric Fire-Stop System Putty, CLK and WRP
3. Thomas & Betts - S-100 FS500/600
4. Specified Technologies Inc. (STI)
5. Hilti Firestop Systems

2.3 BOXES AND CABINETS

A. Outlet Boxes and Covers

1. General Use Boxes shall be galvanized steel, not less than 1-1/2" deep, 4" square or octagonal, with knockouts. Outlet boxes exposed to moisture, exterior, wet or damp locations shall be cadmium cast alloy complete with threaded hubs and gasketed screw fastened covers. Minimum box size shall be as indicated in Article 314 of the National Electrical Code for the conductors and devices installed. Boxes shall be approved for the environmental condition of the location where they will be installed.
2. Boxes installed in damp or wet locations shall be of rain tight construction with gasketed cover and threaded conduit hubs. In no case shall boxes be sized smaller than as indicated in Article 314 of the National Electrical Code for conduit and conductor sizes installed. Boxes shall be approved for the environmental condition of the location where they will be installed.

3. Acceptable manufacturers:

   a. Steel City

   b. RACO

   c. Appleton

   d. Crouse Hinds

B. Floor Outlet Boxes

1. For in slab new or existing construction locations - Provide flush cover service for power or communications/data as called for. Boxes shall be suitable for carpet or tile applications with suitable flange to match finish. Stamped steel, concrete tight, fully adjustable box for above grade. Cast for below or at grade. Provide with larger knockouts where called for on applicable detail. Complete with expandable cap to prevent ingress of concrete during pour. Provide integrated carpet plate/duplex floor plate and duplex receptacle where called for.

2. For above grade applications - Provide UL listed 2-hour rated poke-thru service with power/data/low-voltage outlets. Cover shall have leveling screws with floor flange. Shall include separate metal sleeve for low-voltage and power. Provide with integrated power and low-voltage connectivity jacks where called for on applicable detail.

3. Flush floor junction boxes shall be recessed cover boxes designed for flush mounting in masonry. Provide checkered plate gasketed cover suitable for foot traffic.

4. Acceptable Manufacturers: Hubbell, Legrand

C. Pull and Junction Boxes

1. Shall be constructed of not less than 14 gauge galvanized steel with trim for flush or surface mounting in accordance with the location to be installed. Provide screw-on type covers. Boxes installed in damp or wet locations shall be of rain tight construction with gasketed cover and threaded conduit hubs. In no case shall boxes be sized smaller than as indicated in Article 314 of the National Electrical Code for conduit and conductor sizes installed. Boxes shall be approved for the environmental condition of the location where they will be installed.

2. Acceptable manufacturers:

   a. Hoffman

   b. Keystone

   c. Cooper B-Line

   d. Custom fabricated per. NEC and UL guidelines

D. Terminal and Equipment Cabinets:

1. Terminal and Equipment Cabinets shall be code gauge galvanized steel with removable end walls. Fronts shall be of code gauge steel, flush or surface type (as indicated) with concealed trim clamps, concealed hinges, flush lock, and grey baked enamel finish. Boxes and front shall be U.L. listed and shall be minimum 35"H x 24"W x 6"D. Provide removable insulated plywood terminal board mounted on inside back wall of cabinet.

2. Acceptable manufacturer:

a. Square D "Mono-Flat"

b. Approved equal

2.4 EQUIPMENT BASES, PADS AND SUPPORTING DEVICES

A. Supports, support hardware and fasteners shall be protected with zinc coating or treatment of equivalent corrosion resistance using approved alternative treatment, finish or inherent material characteristic. Products used for outdoor applications shall be hot dipped galvanized.

B. Provide clevis hangers, riser clamps, conduit straps, threaded c-clamps with retainers, ceiling trapeze hangers, wall brackets and spring steel clamps as applicable.

C. 14-gauge U-Channel systems with 9/16-inch diameter holes at a minimum of 1-7/8 inches on center in the top surface. Provide fittings and accessories that match channel.

D. Provide carbon steel or wedge or sleeve type expansion anchors, steel spring head toggle bolts and heat-treated steel power driven threaded stud fastening equipment as required by construction types.

E. Provided field fabricated supporting devices such as angles, channels, pipe supports, etc. All fabricated supports shall be of metal construction.

F. Acceptable Manufacturers:

1. Allied Tube

2. American Electric

3. B-Line

4. Unistrut Diversified Products

5. Cooper Industries

6. Killark Electric Mfg. Co.

7. O/Z Gedney

8. Spring City Electrical Mfg. Co.

9. Thomas & Betts Corporation

2.5 ROOF PENETRATION FLASHING AND SEALING

A. Opening through roofs shall be flashed in manner not to affect roof guarantee or bond. Engage qualified Roofing Contractor licensed by the Roofing Manufacturer, as part of contract. Provide non-ferrous flashing pieces, EDPM skirts, EDPM hoods and collars as required to make ducts, pipes, conduits, and other penetrations watertight. Where curbs are called for with respect to rectangular openings in new roofs, flashing will be done by others unless specifically indicated otherwise. Caulk and waterproof with additional material so as to seal airtight and watertight.

B. Design Equipment: RPS.

C. Acceptable Manufacturers: Pate, Shipman & Son.

2.6 IDENTIFICATION

A. Equipment Identification Nameplates

1. Machine engraved, plastic laminated labels, signs and instruction plates.

2. Material: Engraving stock melamine plastic laminate.

3. Thickness:

a. 1/16-inch minimum thick for signs up to 20 square inches or 8 inches in length.

b. 1/8-inch thick for larger sizes.

4. Color:

a. Background: Black

b. Lettering: White

5. Text:

a. Equipment Designation: Helvetica 3/8" lettering.

b. Supplementary Information (i.e. source, location, nominal voltage, etc.): Helvetica 3/16” lettering.

6. Identification nameplates shall be punched and permanently affixed to the equipment via stainless steel mechanical fasteners.

B. Wiring Device Labeling

1. 0.5” tall, plastic, tear resistant, printer tape label.

2. Color: Black text on clear tape.

C. Raceway & Cable Labeling

1. Adhesive marking labels for raceway and metal-clad cable. The labels shall indicate voltage and service, and be located above ceilings every 75 feet and on wall mounted conduit in mechanical and equipment rooms.

2. Colored self-adhesive vinyl tape, minimum 3 mils thick by 1 inch wide for all phase marking on cable.

D. Underground Conduit and Cabling Labeling

1. 6-inch wide, red colored, warning ribbon plastic tape compounded for direct-burial services. Ribbon shall have aluminum backing making it easy to locate using a non-ferrous locator. Ribbon shall include continuous lettering reading "CAUTION BURIED ELECTRIC LINE BELOW" or similar.

2.7 ARC-FLASH HAZARD WARNING LABELS

A. Standard Label for All Electrical Equipment:

1. Multi-colored self-adhesive vinyl label, minimum dimension 5" wide x 3" high.

2. Shall designate the arc flash hazard for equipment in accordance with NFPA 70E.

3. Label shall include the following information:

a. Text reading: "⚠WARNING ARC FLASH & SHOCK HAZARD APPROPRIATE PPE REQUIRED"

b. Nominal system voltage

c. Arc Flash Boundary

d. The arc flash PPE category in accordance with the Arc Flash PPE Categories Method described in NFPA 70E - Table 130.7(C)(15)(a) Arc-Flash PPE Categories for Alternating Current (ac) Systems.

B. Acceptable Manufacturers:

1. W.H. Brady Co.

2. Markal Corp.

3. National Band & Tag Company

4. Panduit Corporation

5. Cole-Flex Corporation

3.0 PART 3 - EXECUTION

3.1 FIRE STOPPING

A. Installation of Fire-stopping for Openings Through Fire and Smoke Rated Walls and Floor Assemblies shall be as follows:

1. Provide fire-stop system seals at all locations where piping, tubing, conduit, electrical busways/cables/wires, ductwork and similar utilities pass through or penetrate fire rated wall or floor assembly. Provide fire-stop seal between sleeve and wall for dry wall construction.

2. The minimum required fire resistance ratings of the wall or floor assembly shall be maintained by the fire-stop system. The installation shall provide an air and watertight seal.

3. The methods used shall incorporate qualities that permit the easy removal or addition of electrical conduits or cables without drilling or use of special tools. The product shall adhere to itself to allow repairs to be made with the same material and permit the vibration, expansion and/or contraction of any items passing through the penetration without cracking, crumbling and resulting reduction in fire rating.

4. Provide rigid steel sleeves where non-armored cables pass through fire rated walls and barriers.

3.2 BOXES AND CABINETS

A. Consider location of outlets, wiring devices, motor control equipment and other electrical equipment shown on drawings as approximate only. Study architectural, process piping, mechanical, plumbing, structural, roughing-in, etc., drawings and note surrounding areas in which each outlet or equipment is to be located. Locate outlet and electrical equipment so that when fixtures, motors, cabinets, equipment, etc., are placed in position, outlet or electrical equipment will serve its desired purpose. Where conflicts are noted between drawings, contact Owner's Representative for decision prior to installation. Comply with Article 314 of National Electrical Code relative to position of outlet boxes in finished ceilings and walls.

B. Outlet boxes in separate rooms shall not be installed "back-to-back" without the approval of the Owner's Representative.

C. Outlet boxes shall be sized to accommodate the wiring device(s) to be installed.

D. Outlet boxes installed in plaster, gypsum board or wood paneled walls shall be installed with raised plaster covers or raised tile covers.

E. Outlet boxes installed in tile, brick or concrete block walls shall be installed with extra-deep type raised tile covers or shall be 3-1/2" deep boxes with square corners and dimensions to accommodate conductors installed.

F. Surface ceiling mounted outlet boxes shall be minimum 4" square, 1-1/2" deep, galvanized sheet metal.

G. Surface wall mounted outlet boxes shall be cast type boxes having threaded or compression type threadless hubs. Exterior boxes shall be cast type with threaded hubs and gasketed cover plates secured by non-ferrous screws.

H. Floor outlet boxes shall be installed flush with finished floor, adjust level and tilt as required. Where finished floor is terrazzo, provide boxes specifically designed for installation in terrazzo. Where floors are to receive carpet or tile, provide floor outlet with proper flange.

I. Install junction and pull boxes in readily accessible locations. Access to boxes shall not be blocked by equipment, piping, ducts and the like. Provide all necessary junction or pull boxes required due to field conditions and size as required by the National Electrical Code.

3.3 OUTLET BOX ROUGH-IN HEIGHTS:

A. Unless otherwise noted, mount devices and equipment at heights measured from finished floor to device/equipment centerline, except fire alarm as follows:

1.	Light switches	46"
2.	Receptacle outlets	18"
3.	Receptacle outlets, above hot water or steam baseboard heaters.	
	Do not install receptacle outlets above electric baseboard heaters.	30"
4.	Receptacle outlets, hazardous areas	48"
5.	Receptacle outlets, weatherproof, above-grade	24"
6.	Secondary Clock	90"
7.	Wall Mounted Public Address Speaker	90”
8.	Horn Type Public Address Speaker	Min. 180”
9.	Large Venue Fire Alarm Speaker	Min. 180”
10.	Data outlets	18"
11.	Telephone outlets, wall mounted	46"
12.	Fire alarm manual station	46"
13.	Fire alarm audio/visual (bottom of device)	80"
14.	Branch circuit panelboards, to top of backbox	72"

15. Distribution panelboards, to top of backbox 72"

16. Terminal cabinets, control cabinets 72"

17. Disconnect switches, motor starters, enclosed circuit breakers 48"

18. Roof mounted receptacles and disconnect switches 24”

19. Where structural or other interference’s prevent compliance with mounting heights listed above, consult Owner's Representative for approval to change location before installation.

3.4 EQUIPMENT PADS, BASES AND SUPPORTING DEVICES

A. Hangers and Supports:

1. Provide steel angles, channels and other materials necessary for the proper support and erection of motor starters, distribution panelboards, large disconnect switches, pendant-mounted lighting fixtures, etc.

2. Panelboards, cabinets, large pull boxes, cable support boxes and starters shall be secured to ceiling and floor slab and not supported from conduits. Small panelboards, etc., as approved by Owner's Representative, may be supported on walls. Racks for support of conduit and heavy electrical equipment shall be secured to building construction by substantial structural supports.

3.5 IDENTIFICATION

A. Provide equipment identification nameplates on the outside of the enclosure for all equipment indicating the following information:

1. Switchgear, Switchboards, Panelboards, Transformers, Motor Control Centers, Equipment Cabinets, Control Panels, Generators, Uninterruptable Power Supplies:

a. Equipment designation.

b. Source and location of the source.

c. Nominal system voltage.

2. Contactors, Disconnect Switches, Enclosed Circuit Breakers:

a. Equipment designation.

b. Source and location of the source.

c. Nominal system voltage.

d. Location of the load that the switch or breaker serves.

3. Motor Controllers:

   a. Motor designation.

   b. Type of service.

   c. Source and location of the source.

   d. Nominal system voltage.

   e. Location of the motor.

B. Provide equipment identification nameplates for each circuit breaker in all switchgear, switchboards and distribution panelboards listing the panelboard or equipment load connected to each device.

C. Provide wiring devices labeling of all wiring devices. Labeling shall be attached to the outside of the device face plate. Label shall indicate the following information:

1. Panelboard designation and circuit number from which it originates.

D. Provide permanent black marker labeling on all pull boxes and junction boxes indicating the following information:

1. Power & Lighting:

   a. Feeder, branch circuit, and circuit numbers on cover.

   b. Source(s) and location(s) of the sources.

   c. Load(s) and location(s) of the load(s) served.

   d. Nominal system voltage.

2. Systems:

   a. System type.

   b. Panelboard designation and circuit number from which it originates, if applicable.

   c. Equipment location(s) from which enclosed cables originate.

   d. Equipment and location(s) of the equipment served.

   e. Nominal system voltage.

E. Feeders Circuits, Branch Circuits, Control Circuits:

1. 600-volts and Below:

a. Provide cable tags, wire markers, and phase identification tape as appropriate.

b. Identify circuits in each junction box, pull box, outlet box, enclosure, wireway, manhole, handhole, lighting standard base, and at each termination.

c. Identify with source panelboard, circuit number, load, and location served.

d. Include the identification of the building from which it originates for exterior circuits.

F. Underground Conduits & Circuits

1. Provide warning ribbon above the underground electrical installation and 12-inches below finished grade or as appropriate.

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. Provide complete, typed directory for each panelboard listing the room number, function, etc., for each circuit. Provide updated, typed panelboard directories for all existing panelboards affected by this work.

3.6 ARC-FLASH HAZARD WARNING LABELS

A. Provide a standard arc-flash hazard warning label at all new electrical equipment including but not limited to switchboards, switchgear, panelboards, meter socket enclosures, and motor control centers.

3.7 FLASHING AND SEALING

A. Opening through roofs shall be flashed in manner not to affect roof guarantee or bond. Engage qualified Roofing Contractor licensed by the Roofing Manufacturer, as part of contract. Provide non-ferrous flashing pieces, EDPM skirts, EDPM hoods and collars as required to make ducts, pipes, conduits, and other penetrations watertight. Where curbs are called for with respect to rectangular openings in new roofs, flashing will be done by others unless specifically indicated otherwise. Caulk and waterproof with additional material so as to seal airtight and watertight.

3.8 CUTTING AND PATCHING

A. Provide all required Cutting and Patching as outlined in the Summary of Work, Division 1 Specifications.

B. Provide priming and finish coat of paint on walls and surfaces at locations of removed raceways and equipment locations. The paint color and sheen shall match the existing surrounding finish.

C. All penetrations through masonry walls and floors shall be patched with Sakrete FastSet Non-Shrink 3-hour 2,000 psi Grout or equal.

D. All penetrations thru drywall where electrical materials were removed shall be patched with cores or partial pieces of 5/8" minimum thickness drywall and (3) three sanded coats of drywall compound. This shall be followed by priming and painting.

E. The following requirements apply:

1. Perform cutting, fitting and patching of electrical equipment in all following cases:

   a. To uncover work for installation of poorly coordinated or ill-timed electrical work.

   b. To remove and replace defective work.

   c. To remove and replace work not conforming to requirements of the Contract Documents.

2. Remove samples of installed work as specified for testing.

3. Install equipment and materials in existing structures.

4. Cut, remove and legally dispose of all electrical equipment, components, and materials as called for and all other items not indicated on plans but made obsolete by the installation of new work.

5. Protect the structure, furnishings, finishes and adjacent materials not being removed and maintain temporary.

END OF SECTION 260100

SECTION 260503 - TESTING

1.0 PART 1 – GENERAL

1.1 SCOPE

A. Equipment and systems provided by this project shall be tested prior to being placed into service.

B. Provide typewritten documentation of all testing results and maintenance performed.

1.2 RELATED WORK

A. The Contractor shall submit to the Engineer at least three (3) days written notice in advance of the time when equipment is ready for testing. All tests shall be made in the presence of the owner's representative.

1.3 SUBMITTALS

A. Provide a list of all test instruments to be used.

B. Provide a schedule of equipment, tests to be performed, and methods of testing.

1.4 REFERENCES

A. ANSI NETA – Standard for Acceptance Testing Specifications for Electrical Power and Equipment and Systems 2025 Edition.

B. ANSI NETA – Standard for Maintenance Testing Specifications for Electrical Power Equipment and Systems 2023.

C. NFPA – 70B Recommended Practice for Electrical Power Equipment and Systems 2023 Edition.

D. IEEE – Standard 3007.2 – 2010 – Recommended Practice for the Maintenance of Industrial and Commercial Power Systems.

2.0 PART 2 – PRODUCTS

2.1 EQUIPMENT

A. All equipment (i.e., voltmeters, amp probes, load banks, etc.) shall be supplied by the Contractor to perform all tests.

B. All testing equipment shall be up to date on calibration by a qualified calibration service.

3.0 PART 3 – EXECUTION

3.1 TESTING

A. Acceptance Testing

1. Provide visual and mechanical inspection and electrical testing for all new equipment being provided as part of this project per NETA ATS 2025.

2. The following electrical tests shall be conducted:

a) Cables:

(1) Low-voltage, 600-volt maximum

(a) Perform resistance measurements through bolted electrical connections with a low-resistance ohmmeter.

(b) Perform insulation-resistance test on each conductor with respect to ground and adjacent conductors. Applied potential shall be 500 volts dc for 300-volt rated cable and 1000 volts dc for 600-volt rated cable. Test duration shall be one minute.

(c) Perform continuity test to insure correct cable connection.

(d) Verify uniform resistance of parallel conductors.

(e) Existing to be reused conductors:

(i) Perform Very Low Frequency (VLF) Dielectric Withstand Voltage Testing. Apply the test voltage associated with the cable insulation rating for 30 minutes at 0.1 Hz.

b) Switches, Air, Low-Voltage

(1) Perform resistance measurements through bolted connections with a low-resistance ohmmeter.

(2) Measure contact resistance across each switchblade and fuseholder.

(3) Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase- to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer’s published data. In the absence of manufacturer’s data, use NETA ATS Table 100.1.

(4) Measure fuse resistance.

(5) Verify cubicle space heater operation.

(6) Perform ground fault test.

c) Circuit Breakers, Low-Voltage Power

(1) Perform resistance measurements through bolted connections with a low-resistance ohmmeter.

(2) Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase- to-ground with the circuit breaker closed, and across each open pole. Test voltage shall be in accordance with manufacturer's published data. In the absence of manufacturer's data, use NETA ATS Table 100.1.

(3) Perform a contact/pole-resistance test.

(4) Determine long-time pickup and delay by primary current injection.

(5) Determine short-time pickup and delay by primary current injection.

(6) Determine ground-fault pickup and delay by primary current injection.

(7) Determine instantaneous pickup value by primary current injection.

(8) Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. In the absence of manufacturer's data, use Table 100.20.

(9) Verify correct operation of any auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, antipump function, and trip unit battery condition. Reset all trip logs and indicators.

(10) Verify operation of charging mechanism.

d) Grounding Systems

(1) Perform resistance measurements through bolted connections with a low-resistance ohmmeter.

(2) Perform fall–of–potential or alternative test in accordance with IEEE 81 on the main grounding system.

(3) Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and derived neutral points.

e) Motor Control, Motor Starters, Low-Voltage

(1) Perform resistance measurements through bolted connections with a low-resistance ohmmeter.

(2) Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase- to-ground with starter closed, and across each open pole. Test voltage shall be in accordance with manufacturer's published data or NETA ATS Table 100.1.

(3) Test motor protection devices in accordance with manufacturer's published data.

(4) Test circuit breakers in accordance with NETA ATS Section 7.6.1.1.

(5) Perform operational tests by initiating control devices.

f) Adjustable Speed Drive Systems

(1) Perform resistance measurements through bolted connections with low-resistance ohmmeter.

(2) Test the motor overload relay elements by injecting primary current through the overload circuit and monitoring trip time of the overload element.

(3) Test input circuit breaker by primary injection.

(4) Test for the following parameters as recommended by the manufacturer:

(a) Input phase loss protection

(b) Input overvoltage protection

(c) Output phase rotation

(d) Overtemperature protection

(e) DC overvoltage protection

(f) Overfrequency protection

(g) Drive overload protection

(h) Fault alarm outputs

(5) Perform continuity tests on bonding conductors.

(6) Perform startup of drive in accordance with manufacturer's published data. Calibrate drive to the system's minimum and maximum speed control signals.

(7) Perform operational tests by initiating control devices.

(8) Slowly vary drive speed between minimum and maximum. Observe motor and load for unusual noise or vibration.

(9) Verify operation of drive from remote start/stop and speed control signals.

(10) Measure fuse resistance.

3.2 START-UP

A. The Contractor shall provide, at their own expense, equipment manufacturer's representatives to aid in start-up of equipment.

3.3 DOCUMENTATION

A. Provide maintenance and acceptance test reports that at a minimum include all information from the test and inspection reports in Annex E of NFPA 70B.

END OF SECTION 260503

SECTION 260519 - LOW-VOLTAGE CABLES

1.0 PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.

1.2 SCOPE

A. This section includes minimum requirements for the following:

1. Low Voltage Conductors
2. Type MC Metal Clad Cable
3. Connectors and Terminations

1.3 RELATED SECTIONS

A. Specification Section 260503 – Testing.

B. Specification Section 260526 – Grounding.

1.4 SUBMITTALS

A. Provide product data for the following:

1. Low Voltage Conductors
2. Type MC Metal Clad Cable
3. Connectors and Terminations

1.5 QUALITY ASSURANCE

A. All conductors shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

B. Materials specified herein shall comply with the applicable requirements of:

1. The following Articles of the National Electric Code (NFPA 70):

a. 300 – Wiring Methods

b. 310 – Conductors for General Wiring

c. 330 – Type MC Metal Clad Cable

d. 332 – Mineral Insulated Type MI

e. 400 – Flexible Cords and Cables

f. 402 – Fixture Wires

2. The following U.L. Standards:

a. UL 83 – Thermoplastic-Insulated Wires and Cables

b. UL 44 – Thermoset-insulated Wires and Cables

c. UL 486A – Wire Connectors and Soldering Lugs for Use with Copper Conductors.

d. UL 854 – Service Entrance Cable

e. UL 1277 – Electrical Power and Control Tray Cables

f. All Other Applicable Standards

2.0 PART 2 - PRODUCTS

2.1 LOW VOLTAGE CONDUCTORS

A. General purpose feeder and branch circuit and control wiring:

1. Annealed Copper, 98% conductivity.

2. Minimum wire size:

a. #12 AWG for branch circuits

b. #14 AWG for control and signal circuits

3. Wire shall be stranded per ASTM B8.

4. 600 volt insulation for all wiring above 50 volts.

5. 300 volt insulation permitted for all wiring below 50 volts.

6. Thermal plastic with PVC insulation with nylon jacket.

7. Suitable for wet or dry locations, THHN/THWN-2 90 degree Celsius.

8. 90°C maximum operating temperature rating.

9. UL 83 Listed

B. Color Coding

1. Cable outer jackets shall be manufacturer color dyed the entire length for each phase and neutral conductor.

2. Equipment grounding conductors shall be green unless otherwise noted or approved.

3. All conductors shall be color coded according to the following schedule:

Voltage	A PHASE	B PHASE	C PHASE	NEUTRAL
208Y/120V, 3 Phase	Black	Red	Blue	White
480Y/277V, 3 Phase	Brown	Orange	Yellow	Gray
240/120V, 1 Phase	Black	Red		White

*ALL GROUNDING CONDUCTORS SHALL BE GREEN

4. Switched legs shall be identified with the same color insulation as the phase leg.

C. Acceptable Manufacturers:

1. General Cable

2. Southwire

3. Okonite

4. Encore Wire

5. Prysmian

2.2 TYPE MC METAL CLAD CABLE

A. Construction:

1. Stranded or solid copper conductors, each individually insulated, and enclosed in an armor of flexible metal tape.

2. Suitable for wet or dry locations.

3. Suitable for cable tray installations.

4. Do not install direct buried, in concrete, or in the presence of corrosive vapors.

5. Provide with separate integral grounding conductor.

6. Manufactured and installed in accordance with NEC Article 330.

7. Design Make: Same as building wire.

2.3 LOW VOLTAGE CONNECTORS AND TERMINATIONS

A. Straight Splices, #26 AWG To #10 AWG

1. Nylon Insulated compression butt-splices.
2. 600 volt, 90 degree C rated.
3. Make: Burndy “Insulink”, T&B “Sta-Kon”, or approved equal

B. Straight Splices, #8 AWG and Larger

1. Two way, long barrel, compression type, copper
2. Provide heat shrink tubing over splice.
3. 600 volt rated.
4. Make: Burndy “Hylink”, T&N 54800 Series, or approved equal.

C. Pigtail Splices, #26 AWG to #10 AWG

1. Twist type pressure connector.
2. 600 volt rated, 105 degree C.
3. Size as required for number and size of conductors used.
4. Make: T&B Scotchlock, or approved equal

D. Three Way Splices, #8 AWG and Larger

1. Three way, long barrel, compression type, copper.
2. Provide tape or heat shrink tubing over splice.
3. 600 volt rated.
4. Make: Burndy “Hylink”, T&B 54700 Series, or approved equal.

E. Lug Terminations for Control and Signal Wiring.

1. Nylon insulated fork with compression termination of #26 AWG to #10 AWG.
2. Nylon insulated ring with compression termination for #8 AWG and larger.
3. 300 volt rated.
4. Make: Burndy “Insulug”, T&B “Sta-Kon”, or approved equal.

F. Lug Terminations for Power Wiring

1. Long barrel, compression type, copper body, on hole for #8 AWG to #2/0 AWG.

2. Long barrel, compression type, copper body, two hole, for #3/0 AWG and larger.

3. 600 volt rated.

4. Make:

a. One-hole lug: Burndy “Hylug”, T&B 54900 Series, or approved equal.

b. Two-hole lug: Burndy “Hylug”, T&B 54800 Series, or approved equal.

3.0 PART 3 - EXECUTION

3.1 LOW VOLTAGE WIRE AND CABLE

A. General

1. Install cables in raceway as called for after the entire raceway system has been completed.

2. Install splices and connections in accessible outlet, pull, and junction boxes.

3. Insulate all splices and connections with UL Labeled plastic tape, heat shrink tubing, or plastic molded caps.

4. All wiring systems shall be properly grounded and continuously polarized throughout, following the color coding specified.

5. Provide insulated green jacket grounding conductor in each raceway.

6. Provide dedicated white jacket insulated neutral conductor for each individual branch circuit. Shared neutrals are not acceptable.

7. Adhere to NEC de-rating requirements for raceway fill.

8. Provide stranded wire to motors, transformers, equipment, and vibrating machinery.

9. Feeder conductors shall be continuous from point of origin to load termination without splice. If this is not practical, contact the Owner's Representative and receive written approval for splicing prior to installation of feeder(s). Where feeder conductors pass through junction and pull boxes, bind and lace conductors of each feeder together. For parallel sets of conductors, match lengths of conductors.

10. Where multiple conductors are installed in a common raceway they shall be pulled simultaneously. Use of pulling compound or lubricant shall be avoided unless absolutely necessary. Where pulling lubricant is required, use UL approved compounds approved for cable type. Lubricant shall meet all OSHA and Toxic Control Act standards.

Application	Cable Types	Design Make
General Purpose Construction & Maintenance	Rubber, Neoprene, Nylon, PVC, High Density XLP, Hypalon	Ideal – Yellow 77
High Temperature Construction & Maintenance	Rubber, Neoprene, Nylon, PVC, High Density XLP, Hypalon, Low Density Polyethylene, Semiconducting Jacket	Ideal – Yellow 190
Utility Construction & Maintenance	Rubber, Neoprene, Nylon, PVC, High Density XLP, Hypalon, Low Density Polyethylene, Semiconducting Jacket	Aqua – Gel II
Cold Weather Construction & Maintenance	Rubber, Neoprene, Nylon, PVC, High Density XLP, Hypalon, Low Density Polyethylene, Semiconducting Jacket	Aqua – Gel CW

11. Use pulling means including fish tape, cable, rope and basket type grips which will not damage cables or raceways. Use approved mechanical pullers for feeders and branch circuits as required for #6 AWG cable and larger. Do not use mechanical means to pull conductors No. 8 or smaller.

12. Branch circuit conductors installed in panelboards, and control conductors installed in control cabinets and panels shall be neatly bound together using "Ty-Raps" or equivalent.

13. Reconnect branch circuit wiring at panelboards as required to obtain a balanced three phase load on the feeders.

14. Provide conduit seals in explosion proof areas as called for on the plans and as required by the National Electrical Code.

3.2 TYPE MC METAL CLAD CABLE

A. MC cable shall only be permitted for use in 6-feet maximum whips from conduit connected junction boxes above accessible ceiling areas to individual recessed luminaires. Do not daisy chain luminaires with MC cable.

B. Type MC cable may not be used for home runs to panelboards.

C. Type MC cable may not be used for any connections to wiring devices.

D. Type MC cable may not be used for connections to equipment.

E. Type MC cable may not be used for any emergency branch circuits per. Article 517 in the NEC.

F. Support cable per the National Electrical Code. Secure the cable to fixture hangers using nylon or plastic ties.

G. Bending radius shall comply with Article 330.24 of the NEC.

H. Provide insulating bushing at all termination points between the metal sheath and luminaire or junction box.

I. Type MC cable shall not be installed exposed.

3.3 CONNECTORS AND TERMINATIONS

A. Cover un-insulated splices, joints, and free ends of conductor with rubber friction tape or PVC electrical tape. Plastic insulating caps may serve as insulation.

3.4 TESTS

A. Prior to energizing conductors, the contractor shall perform testing in accordance with specification section 260503.

B. Contractor shall supply the Engineer and Owner with cable test results immediately following the test. Provide report of test results and cable lengths in the Operations and Maintenance Manual. Contractor shall be responsible for the removal and replacement of any cable which fails testing.

END OF SECTION 260519

SECTION 260526 - GROUNDING

1.0 PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide a complete grounding system meeting or exceeding the requirements of Article 250 of the latest National Electrical Code. Install all raceway systems, including metal conduit, wireways, pullboxes, junction boxes, bus ducts, enclosures, and motors, to provide a continuous ground path with the lowest possible impedance.

1.2 SCOPE OF WORK

A. This section includes minimum requirements for the following:

1. Conductors

2. Hardware

1.3 RELATED SECTIONS

A. Specification Section 260503 – Testing.

B. Specification Section 260519 – Low-Voltage Cables.

1.4 QUALITY ASSURANCE

A. All grounding systems shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the Contract Documents shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

B. Materials specified herein shall comply with the applicable requirements of:

1. The National Electrical Code, Article 250.

1.5 SUBMITTALS

A. Provide product data for the following:

1. Grounding System Test Reports.

2.0 PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Exposed grounding conductors such as bars, straps, cables, flexible jumpers, braids, shunts, etc., shall be bare copper unless otherwise called for.

B. Conductors shall be copper, as called for in Specification Section 260519 - Low Voltage Cables.

C. Provide conductors with THHN/THWN insulation. Sizes #6 AWG and smaller shall have a continuous green jacket color. Conductor sizes #4 AWG and larger may have green taped bands at each end, and in all pullboxes.

D. Acceptable Manufacturers:

1. Same as for low-voltage conductors. Refer to Specification Section 260519 – Low Voltage Cables.

2.2 CONNECTORS, CLAMPS, TERMINALS

A. General: Connectors specified are part of a system. Furnish connectors and components, and use specific tools and methods as recommended by connector manufacturer to form complete connector system.

B. Splices:

1. Spring Type (for #10AWG conductors and smaller only):

a. Rated 105° C, 600V; Buchanan/Ideal Industries Inc.'s B-Cap, Electrical Products Div./3M's Scotchlok Type Y, R, G, B, O/B+, R/Y+, or B/G+, or Ideal Industries Inc.'s Wing Nuts or Wire Nuts.

2. Indent Type with Insulating Jacket:

a. Rated 150° C, 600V; Ideal Industries Inc.'s High Temperature Wire-Nut Model 73B, 59B.

b. Indent Type with Insulating Jacket: Rated 105° C, 600V; Buchanan/Ideal Industries Inc.'s Crimp Connectors, Ideal Industries Inc.'s Crimp Connectors, Penn-Union Corp.'s Penn-Crimps, or Thomas & Betts Corp.'s STA-KON.

c. Indent Type (Uninsulated): Anderson/Hubbell's Versa-Crimp, VERSAtile, Blackburn/T&B Corp.'s Color-Coded Compression Connectors, Electrical Products Div./3M's Scotchlok 10000, 11000 Series, Framatome Connectors/Burndy's Hydent, Penn-Union Corp.'s BCU, BBCU Series, or Thomas & Betts Corp.'s Compression Connectors.

3. Connector Blocks: NIS Industries Inc.'s Polaris System, or Thomas & Betts Corp.'s Blackburn AMT Series.

4. Resin Splice Kits: Electrical Products Div./3M's Scotchcast Brand Kit Nos. 82A Series, 82-B1 or 90-B1, or Scotchcast Brand Resin Pressure Splicing Method.

5. Heat Shrinkable Splices: Electrical Products Div./3M's ITCSN, Raychem Corp.'s Thermofit Type WCS, or Thomas & Betts Corp.'s SHRINK-KON Insulators.

6. Cold Shrink Splices: Electrical Products Div./3M's 8420 Series.

7. Gutter Taps: Anderson/Hubbell's GP/GT with GTC Series Covers, Blackburn/T&B Corp.'s H-Tap Type CF with Type C Covers, Framatome Connectors/Burndy's Polytap KPU-AC, H-Crimpit Type YH with CF-FR Series Covers, ILSCO's GTA Series with GTC Series Covers, Ideal Industries Inc.'s Power-Connect GP, GT Series with GIC covers, NSI Industries Inc.'s Polaris System, OZ/Gedney Co.'s PMX or PT with PMXC, PTC Covers, Penn-Union Corp.'s CDT Series, or Thomas & Betts Corp.'s Color-Keyed H Tap CHT with HTC Covers.

8. Lugs:

   a. Single Cable (Compression Type Lugs): Copper, one or 2 hole style (to suit conditions), long barrel; Anderson/Hubbell's VERSAtile VHCL, Blackburn/T&B Corp.'s Color-Coded CTL, LCN, Framatome Connectors/Burndy's Hylug YA, Electrical Products Div./3M Scotchlok 31036 or 31145 Series, Ideal Industries Inc.'s CCB or CCBL, NSI Industries Inc.'s L, LN Series, Penn-Union Corp.'s BBLU Series, or Thomas & Betts Corp.'s 54930BE or 54850BE Series.

   b. Single Cable (Mechanical Type Lugs): Copper, one or 2 hole style (to suit conditions); Blackburn/T&B Corp.'s Color-Keyed Locktite Series, Framatome Connectors/Burndy's Qiklug Series, NSI Industries Inc.'s Type TL, Penn-Union Corp.'s VI-TITE Terminal Lug Series, or Thomas & Betts Corp.'s Locktite Series.

9. Acceptable Manufacturers:

   a. Burndy

   b. T & B

   c. Erico

3.0 PART 3 - EXECUTION

3.1 INSTALLATION

A. Raceway Systems:

1. All metal supports, cable trays, frames, sleeves, brackets, braces, etc. for the raceway system, panelboards, switchboards, switches, enclosures, starters, controls, etc., which are not rigidly secured to and in contact with the raceway system, or which are subject to vibration and loosening, shall be bonded to the raceway system. Size the bonding conductor in accordance with NEC Article 250, Table 250.122.

2. Terminate rigid conduit at all boxes, cabinets, and enclosures tightly with two locknuts and a bushing.

3. Conduit which runs to or from all boxes, cabinets, or enclosures having concentric or eccentric knockouts which partially perforate the metal around the conduit and hence impair the continuity of system ground circuits shall be provided with bonding jumpers sized in accordance with NEC Article 250, Table 250.122. Connect the bonding jumper between a grounding type bushing on the conduit and a ground bus or stud inside the box, cabinet, or enclosure.

4. Provide bonding jumpers sized in accordance with NEC Article 250, Table 250.122 for all conduit expansion joints.

5. Provide a grounding conductor in all flexible metallic conduit and liquid-tight conduit, sized in accordance with NEC Article 250, Table 250.122.

6. Provide a grounding conductor in all nonmetallic runs of conduit and raceway, sized in accordance with NEC Article 250, Table 250.122.

7. Provide isolated ground conductors of systems as called for on the plans.

3.2 TESTS

A. Prior to energizing corresponding phase conductors, the contractor shall perform testing in accordance with specification section 260503.

END OF SECTION 260526

SECTION 260533 – RACEWAYS

1.0 PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.

1.2 SCOPE

A. This section includes minimum requirements for the following:

1. Galvanized Rigid Steel Conduit (GRS)

2. Electrical Metallic Tubing (EMT)

3. Flexible Metal Conduit (FMC)

4. Liquidtight Metal Flexible Conduit (LFMC)

5. Rigid Polyvinyl Chloride Conduit (PVC)

6. Fittings

7. Surface Raceway

8. Wireways

9. Cable Hangers

1.3 QUALITY ASSURANCE

A. All raceways shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

B. Materials specified herein shall comply with the applicable requirements of:

1. The following Articles of the National Electric Code (NFPA 70)

a. 300 – General Requirements for Wiring Methods and Materials

b. 314 – Outlet, Device, Pull and Junction Boxes, Conduit Bodies; Fittings; and Handhole Enclosures

c. 344 – Rigid Metal Conduit: Type RMC

d. 348 – Flexible Metal Conduit: Type FMC

e. 350 – Liquidtight Flexible Metal Conduit: Type LFMC

f. 352 – Rigid Polyvinyl Chloride Conduit: Type PVC

g. 358 – Electrical Metallic Tubing: Type EMT

h. 362 – Electrical Nonmetallic Tubing: Type ENT

i. 376 – Metal Wireways

j. 378 – Nonmetallic Wireways

k. 386 – Surface Metal Raceways

l. 388 – Surface Nonmetallic Raceways

m. 392 – Cable Trays

2. The following National Electrical Manufacturers Association (NEMA) Standards:

   a. NEMA, RN1 – PVC Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.

   b. NEMA, TC 3 – PVC fittings for use with Rigid PVC Conduit and tubing.

   c. NEMA, TC 6 & TC 8 – PVC Plastic Utilities for Underground Installation.

   d. NEMA, TC 9 & TC 10 – Fittings for PVC Plastic Utilities Duct for Underground Installation.

3. The following American National Standards Institute (ANSI) standards:

   a. ANSI-C80.1 – Electric Rigid Steel Conduit

   b. ANSI-C80.3 – Specification for Electrical Metallic Tubing, Steel

4. The following U.L. Standards:

   a. UL 1 – Flexible Metal Electrical Conduit

   b. UL 3 – Flexible Nonmetallic Tubing for Electric Wiring

   c. UL 5 – Surface Metal Raceways and Fittings

   d. UL 6 – Electrical Conduit Rigid Metal Conduit, Steel

   e. UL 360 – Liquidtight Flexible Metal Conduit

f. UL 514B – Conduit, Tubing and Cable Fittings

g. UL 651 – Schedule 40, 80, Type EB and A Rigid PVC

h. UL 797 – Electrical Metallic Tubing, Steel

i. UL 870 – Wireways, Auxilliary Gutters and Associated

1.4 SUBMITTALS

A. Provide product data for the following:

1. Conduit

2. Surface Raceway

3. Cable Hangers

2.0 PART 2 - PRODUCTS

2.1 CONDUIT

A. Galvanized Rigid Steel Conduit (GRS)

1. Shall be hot-dipped galvanized steel, including threads.

2. Acceptable manufacturers:

a. Allied Tube

b. Atkore

c. LTV Steel

d. Steel Duct

e. Triangle

f. Wheatland

B. Electrical Metallic Tubing (EMT)

1. Electrical Metallic Tubing shall be electro-galvanized steel.

2. Acceptable manufacturers:

a. Allied Tube

b. Atkore

c. LTV Steel

d. Steel Duct

e. Triangle

f. Wheatland

C. Flexible Metal Conduit (FMC)

1. Flexible Metal Conduit shall be constructed of one continuous length of spirally wound, interlocked, zinc coated strip steel. Interior surface shall be free from burrs or sharp edges.

2. Acceptable manufacturers:

a. American Flexible Conduit Co.

b. Anaconda

c. Atkore

d. O-Z/Gedney

e. Southwire

f. Thomas and Betts

D. Liquidtight Flexible Metal Conduit (LFMC)

1. Flexible Metal Conduit shall be constructed of one continuous length of spirally wound, interlocking zinc coated strip steel. Interior surfaces shall be free from burrs and sharp edges. Provide with a liquid-tight jacket of flexible polyvinyl chloride (PVC).

2. Acceptable Manufacturers:

a. Allied

b. American Flexible Conduit

c. Atkore

d. Carlon

e. Southwire

f. Thomas and Betts

E. Rigid Polyvinyl Chloride Conduit (PVC)

1. Extra-heavy wall conduit: Schedule 80, constructed of polyvinyl chloride, rated for use with 90°C conductors, and UL listed for direct burial and normal above ground use.

2. Heavy wall conduit: Schedule 40, constructed of polyvinyl chloride, rated for use with 90°C conductors, and UL listed for direct burial and normal above ground use.

3. Acceptable manufacturers:

   a. Atkore

   b. Carlon

   c. Certainteed

   d. Condux

   e. Thomas & Betts

2.2 FITTINGS

A. Non-Hazardous Location Fittings:

1. Rigid galvanized steel fittings shall be fully threaded and shall be of the same material as the respective raceway system.

2. Fittings for PVC coated rigid galvanized steel conduit shall be threaded, hot dipped galvanized, and coated inside and outside with a urethane coating.

3. Fittings for electrical metallic tubing shall have plastic insulated throat type. Connection be single set screw indenter for conduits up to 2" and double set screw indenter for conduits 2" and larger.

4. Fittings for flexible metal conduit shall be center stopped, plastic insulated throat type, U.L. E-11852 listed.

5. Fittings for liquid tight flexible metal conduit shall have zinc plated steel ferrule, compression type with sealing ring.

6. Fittings for rigid non-metallic conduit shall be solvent cemented in accordance with the manufacturer's instructions.

7. Die-cast or pressure cast fittings are not permitted.

8. Provide conduit bodies types, shapes and sizes as required to suit application and NEC requirements. Conduit bodies for installation in conduit systems shall allow in-line pull outlets, make 90° bends, “T” take-offs, etc. Provide matching gasketed covers secured with corrosion-resistant screws.

9. Acceptable Manufacturers:

   a. O.Z. Gedney

   b. Steel City

c. Thomas & Betts

d. Crouse-Hinds

e. Carlon

B. Expansion Fittings

1. Galvanized steel expansion joints for RGS or EMT conduit, PVC for PVC conduit.

2. Minimum 4” movement in either direction.

3. Weatherproof for outdoor applications.

4. At expansion joints in concrete pours, provide Deflection/Expansion fittings capable of movement of ¾” in all directions from the normal**.**

5. Design Make: O.Z./Gedney, Type "AX" (exposed), “DX” (Concrete Pour)

6. Acceptable manufacturers:

a. O.Z./Gedney

b. Crouse-Hinds

c. Appleton

C. Underground Ductbank Materials

1. Refer to Specification Section 260543 - Exterior Pathways for underground ductbank materials.

2.3 SURFACE METALLIC RACEWAY

A. One-Piece raceway suitable for (8) #12 AWG conductors or (2) 0.2” O.D. cables

1. Color shall be factory finished white.

2. One-piece steel construction.

3. Surface box w/ matching knockouts as requited at end(s).

4. Design Make: Wiremold 700 Series

B. Two-Piece raceway suitable for up to (9) #12 AWG conductors or (11) 0.2” O.D. Cables

1. Color shall be factory finished white.

2. Two-piece steel construction with single compartment.

3. Nominal 1-3/4” x 7/8” with snap on cover.

4. Surface box w/ matching knockouts as requited at end(s).

5. Design Make: Wiremold 2400 Series

C. Two Channel (Dual Channel) with devices suitable for up to (48) #12 AWG conductors or (50) 0.2" O.D. Cables.

1. Color shall be factory finished white.

2. Two-piece steel construction with removable front cover and divider for power and communications, length as indicated on the drawings.

3. Nominal 4-3/4" x 1-3/4" with snap on matching cover.

4. Provide wiring devices and data/audio/video outlets in the raceway as shown on plans.

5. Design Make: Wiremold 4000 Series

D. Provide miscellaneous boxes, mounting bezels, covers, entrance fittings and supports designed and manufactured by the raceway manufacturer as required making a complete job.

E. Cat.6A and optical fiber installations:

1. Cable entrance fittings shall include 1" min. minimum knockouts.

2. Provide 2" minimum radius fittings.

F. Acceptable Manufacturers:

1. Hubbell

2. Panduit

3. Wiremold

4. Mono-Systems

2.4 WIREWAYS

A. Wireway shall be steel, enclosed type. Provide hinged, JIC sectional NEMA dust resistant, oil tight type where subjected to moisture, in Pump Rooms, Mechanical, Electric and Fan Rooms, exterior walls, Maintenance Shops, and similar locations. Size to meet NEC fill requirements or larger as noted on Contract Documents. Provide knockouts along runs. Provide all elbows, tees, pullboxes, fittings, hangers, reducers, supports, etc., to meet installation requirements.

B. Cover: Screw cover with full gasketing in outdoor installations.

C. Connector: Flanged.

D. Fittings: Lay-in type with removable front; captive screws drip shield in outdoor installations.

E. Finish: Electro-coated ASA-49 Gray Epoxy Paint over Phosphate Primer.

F. Acceptable manufacturers:

1. Square D "Square Duct"

2. General Electric

3. Hoffman

4. Keystone/Rees, Inc.

2.5 CABLE HANGERS

A. Provide prefabricated, zinc coated, carbon steel hangers UL listed to support category 5, 6, 6A, optical fiber cable, and innerduct installations.

B. Hangers shall have open top with spring loaded cable retainer clip.

C. 4” high with rolled vertical and horizontal edges and a 3” deep and 2” wide support flange.

D. Flat bottom profile to reduce cable crushing in center.

E. Stackable with same model hangers below.

F. Provide beam clamps, rod fasteners, flange clips and brackets as job conditions require.

G. Design Make: Mono-Systems H-433-S or Approved Equal

3.0 PART 3 - EXECUTION

3.1 GENERAL

A. Size raceways as indicated on the drawings. Where sizes are not indicated, raceways shall be sized as required by the National Electrical Code in accordance with the quantity, size, type and insulation of conductors to be installed.

B. Minimum 1/2" trade size for branch circuit and fire alarm wiring.

C. Minimum 3/4" trade size for voice/data outlets, television outlets, and branch circuit "Home Runs" to panelboards.

D. Where cable quantities are identified on drawings provide telecom conduit sleeves and raceways according to the below schedule (Note this table is an estimate and the actual quantity is dependent on the installed cable diameter):

Cat. 6 Cable Qty.	Conduit Trade Size
4 Cables	¾" Conduit
6 Cables	1" Conduit
10 Cables	1¼" Conduit
20 Cables	2" Conduit
70 Cables	4" Conduit
Cat. 6A Cable Qty.	**Conduit Trade Size**
2 Cables	¾" Conduit
4 Cables	1" Conduit
6 Cables	1¼" Conduit
10 Cables	1½" Conduit
20 Cables	2½" Conduit
70 Cables	4" Conduit

*Refer to specification section 271000 for maximum outside diameter of UTP cabling.

E. Support raceways from building structure and wall construction. Do not support raceways from ceiling systems ductwork, piping, or equipment hangers. Do not support raceways from pre-existing conduit runs, banks, racks, hangers, etc.

F. Support outlet, pull, and junction boxes independently from building structure and wall construction. Do not support from raceways.

G. Install raceways parallel or perpendicular to building walls, floors and ceilings.

H. Install raceways concealed except in the following areas:

1. Mechanical Rooms
2. Electric Rooms
3. Manufacturing areas
4. Garage or maintenance areas
5. Unfinished basements or crawl spaces

I. Provide a code compliant ground path between all outlets and the established electrical system ground.

J. Cut raceways square, ream ends to remove burrs, and bush where necessary.

K. Coordinate all raceway runs with other trades.

L. Do not install raceways adjacent to hot surfaces or in wet areas.

M. Provide expansion fittings with external grounding straps at building expansion joints.

N. Do not install conduit horizontally in concrete block or dry wall partitions.

O. Arrange neatly to permit access to the raceway, outlet, pull, and junction boxes, and work installed by other trades.

P. If it is necessary to burn holes through webs of beams or girders, call such points to the attention of the Owner's Representative and receive written approval both as to location and size of hole before proceeding with work. All holes shall be burned no larger than absolutely necessary.

Q. Core drill, sleeve, and fire stop all penetrations through existing floors.

R. Support all raceways with malleable iron pipe clamps or other approved method. In exterior or wet locations, provide minimum ¼" air space between raceway and wall. Secure raceway within 3 ft. of each outlet box, junction box, cabinet or fitting.

S. Provide green ground wire in all EMT, flexible conduit, and non-metallic conduit.

T. Do not install voice and data cabling in any surface metal raceway smaller than Wiremold V2400, except single voice outlets where cable runs straight down and no bends occur in raceway.

3.2 CONDUIT

A. EMT conduit is approved for installations in indoor dry locations only.

B. Install with a minimum of bends and offsets. Bends shall not kink or destroying the interior cross section of the raceway. Factory made bends shall be used for raceways 1" trade size and larger.

C. Provide at least one junction or pull box for each 270 degrees of bends.

D. Plug the ends of each roughed-in raceway with an approved cap or disc to prevent the entrance of foreign materials during construction.

E. Provide UL approved rain-tight and concrete-tight couplings and connectors.

F. Secure within three feet of each outlet box, junction box, cabinet or fitting.

G. Provide a #14 AWG fish wire in all "Spare" or "Empty" conduit runs to facilitate future installation of conductors.

H. Install raceways in concrete floor slabs as follows:

1. All conduit in concrete floor slabs shall be rigid galvanized steel with concrete tight threaded fittings.

2. Provide expansion fittings where conduits cross building expansion joints.

3. Install conduit below the reinforcing mesh.

4. Locate conduits to provide a minimum of 1" of concrete around conduit.

5. Obtain approval from the Owner's Representative prior to installing conduit larger than 1" trade size in concrete slabs.

I. Wherever a cluster of four (4) or more conduits rise out of floor exposed, provide neatly formed 4 in. high concrete envelope, with chamfered edges, around raceways.

J. Provide conduit supports based on the following table:

Conduit Trade Size	Type of Run	Horizontal Spacing in Feet	Vertical Spacing in Feet
½", 3/4"	Concealed	7	10
1", 1-1/4"	Concealed	8	10
1-1/2" & larger	Concealed	10	10
½", 3/4"	Exposed	5	7
1", 1-1/4"	Exposed	7	8
1-1/2" & larger	Exposed	10	10

K. Where conduits puncture roof, install pitch pockets as required in order that the roof warranty is maintained.

L. Provide (5) five empty ¾" and (1) empty 1-1/2" raceways from each flush mounted panelboard or cabinet to an area above the nearest accessible ceiling space. Make 90° turn above the ceiling, arranged for further continuation of raceway, and cap.

3.3 RACEWAY SYSTEM INSTALLATION:

A. Wiring above and below 600 volts, exterior below grade locations:

1. Schedule 80 Type PVC Conduit direct buried in sand bed envelope with Rigid Galvanized Steel elbows below all lawn areas and where indicated on drawings.

2. Schedule 40 Type PVC Conduit encased in concrete with Rigid Galvanized Steel elbows below pavement areas, areas subject to vehicular traffic and where indicated on the drawings.

B. Wiring below 600 volts in exterior, above grade locations:

1. Rigid Galvanized Steel where exposed and for the complete roof penetration

2. Final connections to rotating or vibrating equipment: Liquid Tight Flexible Metal Conduit (4-foot maximum length)

C. Wiring below 600 volts, interior above grade locations:

1. Electrical Metallic Tubing where concealed within walls, above ceilings and in unfinished or unoccupied areas.

2. Where unable to conceal in finished occupied areas: Surface Metal Raceway.

3. Electrical or Mechanical rooms where raceway is installed below 10' AFF or exposed to potential damage: Rigid Galvanized Steel

4. Final connections to rotating or vibrating equipment: Liquid Tight Flexible Metal Conduit (4-foot maximum length)

5. Final connections to luminaires: MC cable (6-foot maximum length from EMT conduit & junction box to individual luminaire)

3.4 SURFACE RACEWAYS

A. Support with expansion anchors, concrete inserts, masonry inserts or toggle bolts as field conditions require. Provide supports at five foot centers.

B. Install a separate green ground conductor in raceway from the junction box where surface raceway begins to the ground terminal of the device, fixture or equipment being supplied.

C. Provide all fittings, connectors, elbows, tees, boxes etc. as required for the installation.

D. Submit factory drawings detailing the installation. Include a complete part list.

END OF SECTION 260533

SECTION 260543 - EXTERIOR PATHWAYS

1.0 PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.

B. Cut, excavate, and patch existing asphalt parking lot/roadways and lawn areas for new underground raceway installations as called for on the drawings.

1.2 SCOPE

A. Minimum composition requirements and/or installation methods for the following materials and work are included in this section:

1. Trenching and Excavation
2. Ordinary Fill and Crushed Stone
3. Geotextile Fabric
4. Soil Restoration and Seeding
5. Asphalt Paving
6. Underground Raceway
7. Ductbank Concrete, Forms and Reinforcing
8. Raceway Waterstop Sealant
9. Handholes

1.3 RELATED SECTIONS

A. Specification Section 260533 – Raceways

1.4 SUBMITTALS

A. Product data for:

1. Handholes
2. Asphalt Pavement Supplier and Aggregate Composition

1.5 QUALITY ASSURANCE

A. The contractor shall engage the services of a qualified installer for all excavation and restoration work.

B. All work shall be done in a neat and workmanlike manner. All methods of construction, details of workmanship, that are not specifically described or indicated in the contract documents, shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

1.6 PROJECT CONDITIONS AND REQUIREMENTS

A. The following conditions apply to excavation:

1. Identify and maintain and protect existing building services which cross the excavation area.

2. Protect utilities, sidewalks, structures, pavements and other facilities from damage caused by settling, lateral movements, undermining, washouts and other hazards created by excavation work.

3. Locate and verify existing underground utilities in excavation areas. If utilities are indicated to remain, support and protect services during excavation operations.

4. Verify subsurface conditions prior to excavation work.

B. Obtain as built drawings from the owner for all previous underground work done on the campus. Field verify location of the existing underground utilities and cabling that is shown on these plans. Use tracing equipment as required.

C. The contractor shall be responsible for the repair all existing utilities that are identified on existing as-built drawings or construction documents that are damaged during the installation of contract work.

D. The contractor shall subcontract a qualified mechanical or plumbing contractor to repair any underground piping that is damaged as a result of the installation of contract work.

1.7 MIX PROPORTIONS AND DESIGN

A. Prepare design mixes for each type of strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301. Mix designs submitted for approval shall be less than one year old and shall be representative of the concrete materials currently being used. If trial batch method used, use an independent testing facility acceptable to Engineer for preparing and reporting proposed mix designs. The testing facility shall not be the same as used for field quality control testing.

B. Acceptance of design mix will require that average strength of test cylinders exceed the specified strength (f'c) established by ACI 318 Paragraph 4.3. If a suitable record of strength test performance is not available from the concrete supplier, proportions of the design mix shall be selected to provide an average strength at least 1200 psi greater than the specified strength (f'c).

C. Mix designs may be adjusted when material characteristics, job conditions, weather, test results or other circumstances warrant. Do not use revised concrete mixes until submitted to and accepted by the Engineer.

D. Design mixes to provide normal weight concrete with the following properties, as indicated on Drawings and according to the following schedule:

Concrete Mix Schedule

Use	Compressive Strength (PSI)	Cement Bags Per Cubic Yard	Maximum Aggregate	Maximum Water Cementitious Materials Ratio	Admixture
Ductbank	3000	5-1/2	1-1/2”	0.55	Mid-Range Water Reducer & Air Entrainment

E. Air entraining admixtures are to be used only for concrete exposed to freezing temperatures throughout the life of the structure.

F. Water-cementitious materials ratio: Provide concrete with a maximum water-cementitious materials (W/C) ratio equal to the values provided in schedule above.

G. Field added concrete admixtures: If any approved admixtures are added in the field, the concrete mix shall be spun 30 times at mixing speed to assure adequate uniform mixing of the admixture.

2.0 PART 2 – PRODUCTS

2.1 ORDINARY FILL AND CRUSHED STONE

A. Sand: Clean, coarse, free of organic matter.

B. Type 1 Fill (NYSDOT Type 1 / Granular Fill) graduation requirements:

Sieve No.	Percent Passing Maximum	Percent Passing Minimum
3 in.		100%
2 in.	90%	100%
¼” in.	30%	65%
#40	5%	40%
#200	0%	7%

C. Type 2 Fill (NYSDOT Type 2 / Crushed Ledge Rock Stone) graduation requirements:

Sieve No.	Percent Passing Maximum	Percent Passing Minimum
2 in.		100%
¼" in.	25%	60%
#40	5%	40%
#200	0%	7%

D. Gravel Fill: Well-graded natural inorganic sand and gravel conforming to following graduations:

Sieve No.	Percent Passing Maximum	Percent Passing Minimum
4 in.		100%
1 in.	100%	60%
#4	85%	25%
#16	60%	10%
#50	30%	4%
#200	5%	

E. Pea Gravel: Rounded stone, 3/4 in. maximum diameter, and 1/8 in. minimum diameter. Stone crushings of 1/8 in. to 1/2 in. meeting ASTM C33, Paragraph 9.1 may also be used.

F. Ordinary Fill: Well-graded, natural inorganic soil, meeting the following requirements:

1. Free of organic and other compressible materials, debris and frozen materials, and of stones larger than 4 in. maximum dimension.

2. Be of such nature and character that it can be compacted to the specified densities.

3. Free of highly plastic clays, of materials subject to decay, decomposition, or dissolution, and of cinders, ash and other corrosive materials.

4. Maximum dry density of not less than 115 lbs. per cu. ft.

5. Material from excavation on the site may be used as ordinary fill if it meets the above requirements.

2.2 GEOTEXTILE FABRIC

A. Nonwoven Geotextile Filter Fabric: Polypropylene or polyester fabric

B. 5.6 oz per. yard nonwoven polypropylene fabric minimum, composed of fibers formed into a stable network so that fibers retain their relative position.

C. Fabric shall be inert to biological degradation and resist naturally encountered chemicals, alkalis, and acids.

D. Color: blended black and/or dark grey

E. Tested in accordance with the following ASTM standards: ASTM D4355, ASTM D4491, ASTM D4533, ASTM D4632, ASTM D4751, ASTM D5261, ASTM D6241

F. Nominal Roll Size: 8-feet wide x 100-feet long

G. Design Make: Duraweb Model 23245 or Approved Equal

2.3 SOIL RESTORATION AND SEEDING

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.

1. Quality: Seed of grass species as listed below for solar exposure, with not less than 85 percent germination, not less than 95 percent pure seed, and not more than 0.5 percent weed seed.

2. Sun and Partial Shade: Proportioned by weight as follows:

a. 33 percent Kentucky bluegrass (Poa pratensis).

b. 33 percent chewings red fescue (Festuca rubra variety).

c. 34 percent perennial ryegrass (Lolium perenne).

B. Native Topsoil: To the extent possible, utilize existing, native surface topsoil formed under natural conditions with the duff layer retained during excavation process and stockpiled on-site.

1. Verify suitability of native surface topsoil to produce viable planting soil.

2. Clean soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.

3. Topsoil shall be screened off the field site to remove particles larger than 2 inches.

C. Imported Topsoil: Provide imported topsoil or manufactured topsoil from off-site sources that complies with NYSDOT Section 713.01, as necessary to meet the project needs.

1. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from agricultural land, bogs or marshes.

2. Topsoil shall be free of roots, plants, sods, stones, clay lumps, particles larger than 2 inches, and other extraneous materials harmful to plant growth.

2.4 ASPHALT PAVING

A. Use locally available materials exhibiting satisfactory record of previous installations.

B. Provide paving fabric where used over existing paving. Fabric shall be non-woven polypropylene fabric precoated with rubberized asphalt and protected by release sheet. Design Make: Phillips Fibers Corp. "Petrotac precoated Nonwoven Fabric" or Approved Equal.

C. Asphalt Requirements:

1. Foundation Course: Provide 6" layer compacted in 3" increments. Material shall comply with NYS DOT Standard Type 1 Fill.

2. Base Course: Provide 2" compacted layer or additional material until movement in front of roller ceases. Material shall comply with NYS DOT Standard Type 2 Fill.

3. Tack Coat: Emulsified asphalt, slow setting type, NYS DOT Designation 702-3601 (SS-1h) or 702-4501 (CSS-1h).

4. Asphalt Cement Filler: NYS DOT Designation 702-05.

5. Asphalt Concrete Binder Course: Provide minimum 3" binder course. Material shall be hot plant mixed asphalt concrete complying with NYS DOT Type 3 Binder.

6. Asphalt Concrete Top Course (over existing paving): Provide minimum 1 ½" top course up to 3" to achieve level surface. Material shall be hot plant mixed asphalt concrete complying with NYS DOT Type 7 Top.

D. Painting:

1. Pavement marking paint shall comply with NYS DOT standard 727-01.

E. Compaction Equipment:

1. Provide compaction equipment in suitable size and number, and in satisfactory working condition to complete construction on schedule.

2. Use Self-propelled tandem roller with minimum 10-ton weight. Hand held compactor may be used in areas inaccessible to rollers when approved in advanced by Engineer.

2.5 HANDHOLES

A. Cover and Frame Requirements

1. General:

a. Cover shall have (2) pick holes on opposite sides

b. Cover shall be labeled “Electric” or “Communications”, as indicated on drawings for indicated use.

2. Concrete Type Structures:

a. Grading Rings shall be HDPE construction, available in 1.25 thru 4” thickness.

b. Diameter 24” thru 36”, size as indicated on drawing.

c. Designed for H-20 loading, AASHTO M306 certification

d. Frame shall have (4) bolt holes, reversible type, 4” high

e. Frame and Iron construction: Grey Cast Iron ASTM-A48 Class 35B

3. Polymer Type Structures:

a. (2) stainless steel bolts to secure cover

b. ANSI TIER 15 Rating for driveway, parking lot, and off-roadway applications subject to occasional nondeliberate heavy vehicular traffic.

c. Skid resistant surface on cover

B. Precast Concrete Handhole Structures

1. Accessories: Include Grading Rings shall be HDPE construction, available in 1.25 thru 4” thickness.

2. Specifications:

a. Concrete: 5000psi @ 28 days

b. Entrained Air: 5-9%

c. Design Load: AASHTO H20

d. Reinforcing: Steel rebar ASTM A615

3. Refer to details on drawings for additional information and size requirements.

4. Acceptable Manufacturers:

a. Kistner Concrete Products Inc.

b. Lakelands Concrete Products Inc.

c. Oldcastle Precast Group

C. Polymer Concrete Handholes

1. Refer to details on drawings for additional information and size requirements.

2. Construction: Select-grade aggregates in combination with a polymer resin system and fiberglass reinforcement.

3. ANSI TIER 15 Rating for driveway, parking lot, and off-roadway applications subject to occasional nondeliberate heavy vehicular traffic.

4. Stackable construction, minimum total depth shall be 36”.

5. Factory knockouts on each side accept up to 4” raceway

6. Include solid bottom section on base of stacked assembly

7. Acceptable Manufacturers: Hubbell Quazite PG Style or Approved Equal

2.6 UNDERGROUND RACEWAY

A. Underground straight length conduit sections shall be Schedule 80 PVC.

B. Provide 45-degree and 90-degree Galvanized Rigid Steel (GRS) large radius sweeps at 45-degree and 90-degree conduit. Provide PVC to GRS threaded adapters as required.

C. Couplings shall be mechanically or chemically sealed watertight.

D. Provide deflection joint to allow ¾" movement in all axis, and a total bend of up to 30 degrees. Provide fixed galvanized steel bends or flexible metal conduit bends to allow changes in direction. Fixed or flexible bends shall be provided with factory installed reverse spin coupling. Fixed or flexible bends shall have Nylon 6 innerduct to prevent "burn through" due to friction when tapes, ropes, or cables are installed.

2.7 CONDUIT SPACERS FOR DUCT BANKS

A. Spacers are available in duct sizes 2", 3", 4", 5", and 6" and can be installed horizontally, vertically or turned up-right for unique duct bank configurations. Provide reducers for smaller duct sizes.

B. Installs horizontally or turned upright. Connects to adjacent spacers to support racking of over 12 raceways.

C. Molded-In rebar holder.

D. Nonmetallic, noncorrosive, nonconductive.

E. Nonmetallic snap-loc spacers are designed specifically for use with nonmetallic duct, with maximum O.D. dimensions as specified in NEMA TC-2, TC-6 & 8, TC-10 and ASTM F512.

F. Design Make: Carlon Snap-Loc Spacers

2.8 DUCTBANK CONCRETE

A. Portland Cement: ASTM C150, Type 1A.

B. Aggregates: ASTM C33, Class S. Coarse aggregate to be crushed. Whole gravel is not permitted. Do not use aggregates known to be alkali reactive. (See ASTM C33 Appendix XI).

C. Water: Drinkable.

D. Mid-Range Water-Reducing Non-Chloride Admixture: ASTM C494, Type A (POLYHEED 997 by Master Builders Technologies or approved equal).

2.9 DUCTBANK FORM MATERIALS

A. Concrete to be used for the ductbank encasement is to be cast-in-place using form work to maintain accurate width and clearance of ductbank. All form work shall be removed prior to backfilling. Only under exceptional conditions of soil stability such as hard pan or dense glacial till, shall forms be permitted to be omitted, after individual section review and written acceptance of the Engineer.

2.10 DUCTBANK REINFORCING MATERIALS

A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.

B. Steel Wire: ASTM A 82, plain, cold-drawn steel.

C. Supports for reinforcement: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Use wire bar type supports complying with CRSI specifications.

2.11 RACEWAY PENETRATION SEAL KIT

A. Suitable for use in water, direct ground burial and atmospheric conditions. Provides electrical isolation where cathodic protection is required.

B. Compression Element: EPDM (Black) Plates

C. Pressure Plates: Reinforced Nylon Polymer

D. Bolts & Nuts: 316 Stainless Steel

E. Temp. Range: -40 to +250ºF (-40 to +121ºC)

F. Design Make: Link-Seal Model “C” or “L” Modular Seal

2.12 RACEWAY WATERSTOP SEALANT

A. Flowable mixture expands and hardens to a semi-permanent, but removable, seal. The foam wets and adheres to metals, plastics, and concrete. It conforms around complex cable fill configurations to keep out moisture, gases, dust, insects, and rodents.

B. Holds 22 feet (6.7 m) of water head pressure and up to 90-foot (27 m) surges.

C. Seal conduits from 2" to 5" with conductors and is re-enterable.

D. Compatible – Use with a wide range of cable jacket and conduit materials.

E. Solves Critical Application – Class 1, Div. 2, cold storage entrances approximate R-Value of 6.5/inch.

F. Design Make: Polywater FST Foam Duct Sealant or Approved Equal

3.0 PART 3 - EXECUTION

3.1 EXCAVATION AND TRENCHING

A. Preparatory Work:

1. Build lines to grade and elevations shown. Provide stakes, grade boards, cleats, nails, instruments. Locate and stake each new run for its entire length. Verify elevations given. Start excavation at low point. Notify Engineer of elevation discrepancies. Protect marks and stations. Before excavating work, coordinate with Owner's Site Representative and other trades. Furnish schedule of operations to Owner and each trade. Provide and maintain temporary bridges, walks and bridges over excavations where underground utility lines, sewers, water lines, etc., cross access roads, walks, and streets. Make necessary arrangement with authorities having jurisdiction.

2. Examine substrates, areas and conditions, with the installer present, for compliance with requirements for installation tolerances and other conditions affecting installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Protection:

1. Provide bracing, shoring, sheathing and other work for: protection of personnel, the contract work, excavations, trees, shrubs, existing structures, and surrounding properties. Slope sides of excavations to comply with local codes and ordinances. Provide, erect, and maintain barricades, warning signs, flags, and lights to provide protection for work, workmen, public, and property. Plank walks, pavements, and curbs to be crossed by equipment. Protect adjacent property, existing fences, trees, shrubs, roads, curbs, sidewalks, manholes, hydrants, and other items:

2. Restore, repair, rebuild or replace any such items damaged or destroyed to condition equal to that existing before such damage occurred.

3. Establish conditions, before starting work, by taking photographs to determine state to which existing conditions must be restored. Submit such photographs notarized, identified and dated for record.

C. Existing Utilities:

1. There are existing underground district electric and telephone utilities. Obtain the districts existing site utility plans for each building prior to beginning work. Identify utilities shown on the plans.

2. The existing district owned telephone cables are not documented. Prior to beginning any excavation work, identify the path of the existing cables using cable tracing equipment.

3. If existing telephone or electric cables are broken during the new installation the contractor shall repair to new condition.

4. Report immediately any utility lines encountered.

5. Notify Underground Facilities Protection Organization (UFPO), where same exists, before starting work. Phone (800)-962-7962 for information and location of nearest organization address and telephone number. Verify exact location of existing utility lines where work crosses existing utilities and where connections are to be made by test hole before starting work. Notify utility companies, municipalities, and other involved jurisdictions when excavation occurs within vicinity of existing underground service such as sewers, water, electric, gas, telephone, including such services owned by Owner.

6. If existing service lines, utilities and utility structures which are to remain in service are uncovered or encountered during this excavation, they shall be protected from damage, and securely supported as directed and approved by the involved jurisdiction. Comply with Section 1918 of Penal Law of State of New York with regard to work in vicinity of combustible gas piping. Immediately report damage or injury to utility lines to Owner's Representative and involved jurisdiction. Repair or replace utility lines damaged or injured as directed and approved by the involved jurisdiction. Excavate by hand in proximity to existing underground utility lines; take extreme care when excavating around ductbanks carrying energized cable. Remove plug or cap inactive or abandoned utilities encountered during construction operations. The location of such utilities shall be noted on the record drawings. Verify "inactivity" of services with involved jurisdiction before start of work.

D. Cutting and Patching

1. Before starting work, obtain necessary permits and pay fees and charges for same. Cut paved areas as called for, perpendicular to surface and in straight saw-cut lines. Replace pavements, roadways, streets, blacktop areas, walks, disturbed by excavating operations with materials equal to adjacent pavements.

E. Methods

1. Provide for buried work in contract both inside and outside of building. Excavate to proper depth and width for installation work as called for and comply with rules set forth by New York State Department of Labor. Remove materials including masonry work, rubble, earth, brickwork, concrete, sand, debris, abandoned pipe lines, drains and sewers, rocks, boulders, and concrete, all of which is considered "earth excavation." Provide for legal disposition of excess excavated materials. Make allowance for gravel fill, sand bases, form work, floor slabs, manholes, anchor and thrust blocks, sheet piping, drainage pumps, and work space. Start excavation at rough grade and provide form work and sheet piling where required.

2. Trench excavation:

   a. By open cut, to proper depth and grade no wider than required for placement of work and not more than 100 ft. in advance of utility being installed.

   b. Should trench bottom be wet, unstable, and/or otherwise incapable of supporting the contract work, immediately report same to Owner' Representative. Should it be deemed unsuitable, excavate to depth as directed and back fill with gravel to trench depth, or provide concrete cradling.

   c. Should rock be encountered, excavate 6 in. deeper and fill space between trench bottom and pipe with coarse sand, well tamped to form firm bed.

F. Backfill and Geotextile Fabric

1. After excavation to sub-grade for all new equipment pads and trenching where indicated on drawing; install Geotextile fabric level and extending to sub-grade excavation and to envelope new backfill. Pin geotextile fabric 18” O.C. around perimeter and on vertical wall faces.

2. Provide bedding around piping with coarse sand from 6 in. below to 8 in. above. Apply by hand and compact under and at sides by mechanical means

3. Piping, jackets and sand bed must be inspected and tested prior to backfill of any nature. Provide necessary anchors, thrust blocks, for testing.

4. Fill remainder of trench in 12 in. layers, use ordinary fill material, except as otherwise specified. Do not use frozen material. Remove boulders, stones, broken rock, wood, bricks, blocks, and debris from fill material before backfill operation.

5. Under roadways, manholes, drives, parking areas, walks, slabs, on grade and at utility entrance to building provide backfill in 6 in. layers with gravel or crushed stone, free from organic or other unsuitable material, to grade. Thoroughly compact each layer.

6. Compaction to not less than 95% density compared to maximum laboratory tests by weight, per modified ASTM D1557-64T, latest editions, method "A" under slab on grade, roadways, drives, and other paved areas and 85% for general grading. Submit certified results of tests by an approved soil testing laboratory.

G. Paving

1. Compact each individual material layer as specified.

2. Adjust grading of finish coat to match surrounding surfaces.

3. Finished surface shall be free from depressions, footprints, or imperfections that may collect water or are clearly visible.

4. Repair and repaint of traffic control and parking lot lines to match existing.

H. Removal of water

1. Provide pumps, hoses, pipe, labor and fuel, necessary to keep excavations free of water accumulation. Maintain and operate equipment. Discharge water in manner not interfering with any trade's work and not to undermine or disturb existing or adjacent structures or land. Grade to prevent surface water from flowing into all excavations and trenches. Do not discharge dirt, backfill, debris, into sanitary or storm drainage systems.

I. Rock Excavation

1. Rock Excavation defined as:

a. Ledge rock requiring blasting or air hammer for removal.

b. Boulders in excess of 1-1/2 cu. yds. in size. Demonstrate that material in question cannot be removed with a 1-1/2 yd. backhoe or shovel.

c. Procedure: Should rock be encountered, remove only upon written order of the Owner’s representative.

2. Measurement of rock excavation, for purpose of payment to Contractor, will be taken 1 ft. wider than ductbank, manhole, pipe or conduit being installed. No allowance made for additional rock taken out accidentally or for convenience of Contractor beyond amount required for installation of work. Rock excavation claimed must be measured each day and verified by Owner's Representative. Maintain daily accounting. No claim for extra compensation honored except through procedures outlined above.

J. Job completion:

1. On completion of the work, clean the entire site, remove surplus earth, large stones and debris, to off-site legal disposal. Remove tools and equipment and leave the entire area in a neat condition.

2. Rough grade to 6 in. below finished grade. Scarify subsoil to depth of 2 In. to achieve bond between topsoil and subsoil.

3. Repave, reseed and completely restore the area to the condition prior to the start of excavation and trenching work.

3.2 UNDERGROUND RACEWAYS

A. Where raceways and/or ductbanks penetrate foundation, footings or outside walls, provide rigid metallic conduits with expandable rubber shields shall be used.

B. Where raceways enter manholes, they shall be centered as nearly as possible to the center between roof and floor and end walls.

C. Securely tie raceways in place to prevent floating.

D. Provide Raceway Waterstop Sealant in all new raceways installed into buildings or structures.

E. Pull iron-shod mandrel not more than ¼" smaller than bore of raceway to remove concrete and other obstructions. Clean raceway by drawing cylindrical brushes through duct.

F. Provide metallic elbows where conduits rise out of ground.

G. Provide nylon pull strings in all innerducts and individual pathways inside raceways.

H. Seal all conduits watertight prior to backfill.

I. Provide bushings at each conduit termination.

J. In locations where non-metallic raceways are used, change to heavy wall metallic conduit of same internal diameter before rising out of ground; provide metallic conduit elbows at conduit rise.

K. Place conduit in straight lines. Place direct-bury conduit tier-by-tier method, backfilling each layer to achieve proper spacing. Elbows shall have a minimum radius of 36 in. Follow proper low temperature installation procedures as recommended by PVC conduit vendor. Repair or replace all existing utilities and facilities damaged, due to new installations as part of contract.

L. Provide a bushing at each conduit termination unless fitting at box where conduit terminates has hubs designed in such a manner to afford equivalent protection to conductors. Provide grounding type insulated bushings on all conduit sizes 1-1/4" trade size and larger, and on all feeder raceways regardless of size.

M. Place warning tape over ductbank per detail on the drawings.

N. Provide #12 AWG copper wire with THWN insulation in all spare conduit for tracing purposes. Wire shall be continuous.

3.3 FORMS

A. Design, erect, support, brace and maintain formwork to support vertical and lateral static and dynamic loads that might be applied until such loads can be supported by concrete structure. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation, and position. Maintain formwork construction tolerances as noted in ACI 347, Section 3.3.1.

B. Design formwork to be readily removable without impact, shock, or damage to cast-in-place concrete surfaces and adjacent materials.

C. Construct forms to sizes, shapes, lines, and dimensions shown, and to obtain accurate alignment, location, grades, level, and plumb work in finished structures. Provide for openings, offsets, sinkage, keyways, recesses, chamfers, blocking, bulkheads, anchorages and inserts, and other features required in work. Use selected materials to obtain required finishes. Solidly butt joints and provide back-up at joints to prevent leakage.

3.4 PLACING REINFORCEMENT

A. Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars", for details and methods of reinforcement placement and supports, and as herein specified. Reinforcement shall be a Class 1 reinforcing system.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials which reduce or destroy bond with concrete.

C. Accurately position, support, and secure reinforcement against displacement by formwork, construction, or concrete placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as required.

D. Place reinforcement to obtain at least minimum coverages for concrete protection. Arrange, space and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.

3.5 PREPARATION OF FORM SURFACES

A. Clean re-used forms of concrete matrix residue. Repair and patch as required to return forms to acceptable surface condition.

B. Coat contact surfaces of forms with a form-coating compound before reinforcement is placed.

C. Thin form-coating compounds only with thinning agent of type, and amount, and under conditions of, form-coating compound manufacturer's directions. Do not allow excess form-coating material to accumulate in forms or to come into contact with in-place concrete surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer's instructions.

3.6 CONCRETE PLACEMENT

A. Preplacement Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast-in. Notify other crafts to permit installation of their work; cooperate with other trades in setting such work. Moisten wood forms immediately before placing concrete where form coatings are not used.

B. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as specified herein. Deposit concrete as close as practicable to its final location to avoid segregation.

C. Placing Concrete in Forms: Deposit concrete in forms in horizontal layers not deeper than 24″ and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.

1. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures for consolidation of concrete in accordance with ACI Specifications.

2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than visible effectiveness of machine. Place vibrators to rapidly penetrate placed layer and at least 6″ into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of mix.

D. Cold Weather Placing: Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures, in compliance with ACI 306.1 and as herein specified.

1. When the air temperature has fallen to or is expected to fall below 40°F (4°C), uniformly heat water and aggregate before mixing to obtain a concrete mixture temperature of not less than 50°F (10°C), and not more than 80°F (27°C) at point of placement.

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 and other materials containing antifreeze agents or chemical accelerators, unless otherwise accepted in mix designs.

E. Hot Weather Placing: When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete as herein specified.

1. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90°F (32°C). Mixing water may be chilled, or chopped ice may be used to control temperature provided water equivalent of ice is calculated to total amount of mixing water. Use of liquid nitrogen to cool concrete is Contractor's option.

2. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.

3. Fog spray forms, reinforcing steel and subgrade just before concrete is placed.

3.7 SHORES AND SUPPORTS

A. Remove shores and reshore in a planned sequence to avoid damage to partially cured concrete. Locate and provide adequate reshoring to safely support work without excessive stress or deflection.

3.8 REMOVAL OF FORMS

A. Formwork not supporting weight of concrete, such as sides of ductbank and similar parts of the work, may be removed after cumulatively curing at not less than 50°F (10°C) for 24 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form removal operations, and provided curing and protection operations are maintained.

3.9 LANDSCAPE RESTORATION AND INSTALLATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by sod clearing operations.

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.

C. Install weed-fabric and geotechnical fabric installations after sub-grading is complete. Stake locations, outline areas, adjust locations when requested, and obtain Architect's acceptance of layout before back-fill or plantings. Make minor adjustments as required.

D. Apply nonselective, pre-emergent herbicide that inhibits growth of grass and weeds.

E. Place indicated thickness of stone, fully covering weed barrier. Rake mulch to a uniform surface level with adjacent finish grades

3.10 SEEDING

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph.

1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.

2. Do not use wet seed or seed that is moldy or otherwise damaged.

3. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.

B. Sow seed at a total rate of 4 lb/1000 sq. ft.

C. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.

D. Protect seeded areas with slopes exceeding 1:4 with erosion-control blankets and 1:6 with erosion-control fiber mesh installed and stapled according to manufacturer's written instructions.

E. Protect seeded areas with slopes not exceeding 1:6 by spreading 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.

1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.

F. Protect seeded areas from hot, dry weather or drying winds by applying peat mulch within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch, and roll surface smooth.

3.11 TURF RESTORATION

A. Restore all turf damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.

1. Reestablish turf where settlement or washouts occur or where minor regrading is required.

2. Install new topsoil as required.

B. Remove sod and vegetation from diseased or unsatisfactory turf areas; do not bury in soil.

C. Remove topsoil containing foreign materials, such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil.

D. Mow, dethatch, core aerate, and rake existing turf.

E. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.

F. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.

G. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches.

H. Apply soil amendments and initial fertilizer required for establishing new turf and mix thoroughly into top 4 inches of existing soil. Install new planting soil to fill low spots and meet finish grades.

3.12 HANDHOLES

A. Locate to avoid unnecessary hazards and cause minimum interference with normal traffic flow. Locate outside traveled parts of road wherever possible.

B. Where possible, conduits entering handholes shall include an end bell fitting. Use center conduit entrances and factory knockouts to underground structures.

C. Seal all conduits watertight at entrances to buildings after handhole connections.

D. Provide grading rings in 1.25 thru 4” thickness to adjust frame and cover height to finished grade on top of concrete handholes.

E. Adjust cover and finished grade for flush installation after settlement.

END OF SECTION 260543

SECTION 260620 - WIRING DEVICES

1.0 PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.

1.2 SCOPE

A. This section includes minimum requirements for the following:

1. Receptacles
2. Switches
3. Electric Hand Dryers
4. Coverplates

1.3 QUALITY ASSURANCE

A. All wiring devices shall be installed neatly, and parallel with building lines. Recessed devices shall be flush with the face of the wall. Provide extension rings on outlet boxes as required. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

1.4 SUBMITTALS

A. Provide product data for all wiring devices and cover plates.

B. Indicate selected part numbers.

C. Indicated selected color selections.

2.0 PART 2 - PRODUCTS

2.1 GENERAL

A. Wiring devices shall be heavy duty specification grade at a minimum. Standard commercial grade is not acceptable.

B. Wiring device color shall be white.

C. Suitable for installation in a 2-1/2” deep outlet box.

D. All receptacles and switches shall be from the same manufacturer.

E. Acceptable Manufacturers:

1. Eaton

2. Hubbell

3. Legrand Pass & Seymour

4. Leviton

2.2 DUPLEX RECEPTACLES

A. 125-volt, 20-ampere, two pole, three wire, grounding, straight blade, NEMA 5-20R.

B. Side and back wiring.

C. 0.32” thick brass three prong power contacts and #8 brass screws

D. Brass center rivet

E. All brass grounding system

F. Nylon face with glass reinforced nylon back

G. Dielectric voltage withstands 2,000V minimum

H. Terminals Identified in accordance with UL 498

I. Thermoplastic tamper resistant shutters

J. UL 94 V2 Flame rating

K. Design Make: Pass & Seymour TR5362 Series

2.3 GFI RECEPTACLES

A. 125-volt, 20-ampere, two pole, three wire, grounding, straight blade, NEMA 5-20R.

B. LED trip/test indication

C. Thermoplastic tamper resistant shutters

D. Side and back wiring.

E. Nylon face and back.

F. 2006 UL 943 revisions including “no power to the face when miswired” and “end of life indication” when unit is no longer capable of providing GFCI protection

G. Designed to trip at maximum 6mA leakage current to ground.

H. Suitable for feed through protection.

I. Design Make: Pass & Seymour 2097TR Series

2.4 SPECIAL RECEPTACLES

A. Terminals identified in accordance with UL 498 (X, Y, Z, white, green)

B. H and cord clamp housing material: Black Nylon.

C. Terminal material: Clear Polycarbonate.

D. Contact spring material: Brass.

E. Dielectric Voltage withstands 2,000V minimum

F. Include NEMA type as called for on drawings to match equipment. At a minimum the manufacturer shall have special purpose receptacles available to meet the following NEMA connection types:

1. 125-volt, 20-ampere, 2 pole, 3 wire, grounding, Twist lock, NEMA L5-20R

2. 125-volt, 30-ampere, 2 pole, 3 wire, grounding, Twist lock, NEMA L5-30R

3. 250-volt, 20-ampere, 2 pole, 3 wire, grounding, Twist lock, NEMA L6-20R.

4. 250-volt, 50-ampere, 2 pole, 3 wire, grounding, Twist lock, NEMA L6-50R.

5. 250-volt, 50-ampere, 2 pole, 3 wire, grounding, Straight, NEMA 6-50R.

6. 250-volt, 20-ampere, 2 pole, 3 wire, grounding, NEMA 6-20R

7. 250-volt, 30-ampere, 2 pole, 3 wire, grounding, NEMA 6-30R

8. 125/250-volt, 50-ampere, 3 pole, 3 wire, grounding, NEMA 10-50R

9. 125/250-volt, 30-ampere, 4 pole, 4 wire, grounding, NEMA L14-30R (Dryer Receptacle). Plug configuration to match equipment furnished by equipment supplier.

10. 125/250-volt, 50-ampere, 4 pole, 4 wire, grounding, NEMA L14-50R (Range Receptacle). Plug configuration to match equipment furnished by equipment supplier

2.5 SWITCHES

A. 120-277 VAC, 20 ampere rated.

B. Side or back wired.

C. Quiet operation.

D. Single pole, three way, and four way as called for on the plans.

E. Design Make:

1. Single pole: Pass & Seymour PS20AC1 Series

2. Three -way: Pass & Seymour PS20AC3 Series

3. Four-way: Pass & Seymour PS20AC4 Series

2.6 KEY SWITCHES

A. 120-277 VAC, 20 ampere rated.

B. Locking type. Provide (1) key per switch, all keyed alike.

C. Side or back wired.

D. Quiet operation.

E. Single pole, three way, and four way as called for on the plans.

F. Design Make:

1. Single pole: Pass & Seymour PS20AC1_L Series

2. Three-way: Pass & Seymour PS20AC3_L Series

3. Four-way: Pass & Seymour PS20AC4_L Series

2.7 MOMENTARY SWITCHES

A. 120-277 VAC, 20 ampere rated.

B. Momentary contact.

C. 2 circuit, 3 position, “center off”.

D. Side wired.

E. Quiet operation.

F. Design Make: Pass & Seymour 1251 Series

2.8 ELECTRIC HAND DRYERS

A. 4” Deep ADA Complaint

B. 120 volt, 12.5 amps, 60 Hz, single phase electric hand dryer with 430mph air speed output. Brushless motor.

C. Automatic infrared optical sensor operated.

D. 79 dB sound power output.

E. Surface mount stainless steel or nickel housing.

F. 5-year warranty.

G. Design Make: Dyson Airblade V

H. Approved Equal: World Dryer VERDEdri

2.9 COVERPLATES

A. Provide type 302 stainless steel with satin finish coverplates for general purpose flush devices.

B. Provide utility cover plates for surface mounted devices in mechanical rooms.

C. Provide gasketed weatherproof cover plates with a hinged cover on a cast aluminum outlet box for all devices in wet areas designated “WP”.

2.10 WEATHERPROOF COVERS

A. Impact resistant polycarbonate, NEMA 3R construction.

B. Clear cover to view the connection of the device.

C. UL listed as a weatherproof enclosure with the receptacle in use.

D. Hinged, latching cover with an opening at the bottom for a cord to exit the device.

E. Padlockable

F. Suitable for installation of a GFI protected duplex receptacle.

G. Design Make: Hubbell WP26MP

H. Acceptable Manufacturers:

1. Eaton

2. Hubbell

3. Legrand Pass & Seymour

4. Leviton

3.0 PART 3 - EXECUTION

3.1 GENERAL

A. Install devices generally where called for.

B. Coordinate exact locations of all devices with equipment, millwork, counters, fin radiation, windows, etc. and adjust locations as required as part of this contract.

C. Provide steel box for all devices.

D. Install receptacles and switches vertical, with the grounding pin down, and the toggle up in the on position.

E. Install all switches on the strike side of the door, with the edge of the outlet box approximately 3" from the door frame.

F. Do not install devices "back to back" in the same stud cavity without prior approval of the Owner. Offset devices as required to maintain code required fire rated assemblies or provide fire-stopping assembly around adjacent devices.

G. Provide plaster rings on all outlet boxes to permit flush installation of devices.

H. In all wet or damp areas, provide a surface mounted cast aluminum outlet box with threaded connections, gasketed cover, and non-ferrous screws.

I. Prior to installation and as part of the contract, relocate any device a distance of 5 feet in any direction at the request of the Owner.

J. Size outlet boxes in accordance with the NEC, based on the number and size of wires in the box.

K. Provide a coverplate on all devices.

3.2 EQUIPMENT MOUNTING HEIGHTS:

A. Refer to Specification Section 260100 – Basic Materials and Methods for mounting heights.

3.3 HAND DRYERS

A. Provide fastener types and blocking as required for existing tile-covered walls.

3.4 LABELING

A. Provide tape labels indicating panelboard and circuit on the outside of all device coverplates.

3.5 TESTING

A. Test all receptacles for proper voltage, polarity, and grounding.

B. Test all GFI receptacles for proper voltage, polarity, grounding, and verify the receptacle trips at 6 milliamperes or less.

C. Rewire receptacles as required until receptacles test properly.

END OF SECTION 260620

SECTION 260923 – WIRED LIGHTING CONTROLS

1.0 PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide complete installation, including luminaires, standards, hangers, supports, fittings, lamps, wiring, connections and controls, as indicated in the Contract Documents. Types of luminaires in this project include LED.

B. Provide startup of all lighting control systems by a factory certified manufacturer's representative in order to maintain all warranties. The contractor shall complete all startup request forms and complete all pre-startup installations a minimum of 2-weeks in advance or as otherwise required by the manufacturer. Provide initial system settings and owner training.

C. Provide Lighting System Functional Testing as described in this section by a factory authorized manufacturer's representative hereby referred to as the Testing Agent.

D. Refer to the General and Supplementary Conditions, Division 1 Specifications Sections for proposed phasing of this project. Provide manufacturer certified startup of all lighting control systems and Lighting System Functional Testing in each phased project area as required to turn each area over independently. The appropriate number of site visits to accomplish this phased scope of work shall be included in the base bid.

E. Refer to Specification Section 019113 for commissioning requirements related to this project.

1.2 SCOPE OF WORK

A. This section includes minimum requirements for the following:

1. Room Controllers
2. Power Packs
3. Low-Voltage Switches
4. Occupancy Sensors
5. Dimmer Switches
6. Timer Switches
7. Photo Sensors
8. System Functional Testing

1.3 SUBMITTALS

A. Submit shop drawings as described in Section 260010. Shop drawings shall include photometric data for each luminaire utilizing the specified lens/louver type, lamp(s) and ballast(s). All luminaire types and lighting control system components shall be submitted in a single complete brochure which shall be in the form of a soft cover binder with each luminaire separated by an identified index tab.

1. Room Controllers, Power Packs and Wiring Diagrams

2. Low Voltage Switches

3. Occupancy Sensors

4. Dimmer Switches

5. Timer Switches

6. Photo Sensors

a. Include data that indicates where the sensor shall be installed.

B. Submit for approval information detailing startup of the lighting control systems and the individual(s) who will be performing this service. Include documentation from the lighting control systems manufacturer indicating that they certify said individual(s) to perform this work. Submittal will be rejected if this information is not included.

C. Submit for approval a testing plan for all lighting control systems. Testing plan shall, at a minimum, observe and record all items described in the "Lighting System Functional Testing" part of this section and the individual(s) who will be performing this service. Include documentation from the lighting control systems manufacturer indicating that they authorize said individual(s) to perform this work. Submittal will be rejected if this information is not included.

1. Lighting System Functional Testing

a. Submittal of Functional Testing company name

b. Light meter to be used

c. Functional Testing Report after final adjustments are made

D. Warranty Information

1.4 QUALITY ASSURANCE

A. Lighting controls shall be standard products of manufacturers regularly engaged in the manufacture of the specific type of controls specified and shall be the manufacturer's latest standard design that complies with specification requirements. Firms installing the lighting controls shall have a minimum of five (5) years of successful installation experience on projects with interior lighting and controls work similar to the requirements of this project.

B. Codes and Standards

1. NEC:

a. Shall comply with Articles 220, 410 and 510 as applicable to installation and construction.

2. NEMA:

a. Shall comply with Standard Publication Nos. LE 1 and LE 2 as applicable to lighting equipment.

3. UL:

a. All interior lighting components shall be UL listed and labeled.

b. Comply with all applicable UL standards including UL 486A and B.

4. All work shall comply with applicable local code requirements of the authority having jurisdiction.

1.5 SEQUENCE OF OPERATION

A. Configure set-points and provide necessary programming to the local Room Controller(s). power packs or stand-alone line voltage or low-voltage controls devices to operate as listed below.

B. Initially Unoccupied Room with Multiple Luminaires:

1. Turn on manual switch for each lighting zone (single, multi-level, daylight) to initially turn on luminaires (Per NYS Energy Conservation Code) or automatically turn on luminaires to not more than 50% power.

2. Within a daylight zone, lighting output dims up/down via output from a photocell(s) to adjust and maintain a 40-footcandle minimum light level in the daylight zone.

3. Occupancy sensor utilizes infrared or dual technology (infrared/ultrasonic or infrared/acoustic) to detect occupants and keep luminaires on at 100% output level.

4. Upon occupants leaving room, occupancy sensor keeps luminaires on for a set time delay (20-minutes). If no occupants are detected over the course of the time delay, occupancy sensor turns all luminaires off.

5. Upon occupants re-entering the room, light switch shall be manually used to turn the luminaires back on or automatically turn on luminaires to not more than 50% power.

6. Sequence then repeats.

C. Initially Unoccupied Corridor, Restroom, or Stairwell:

1. Key switch per. plans for each lighting zone (single, multi-level, daylight) to initially turn on luminaires (Per Energy Conservation Code of New York State).

2. Occupancy sensor utilizes passive infrared and ultrasonic or passive infrared and acoustic technology to detect occupants.

3. Upon occupants leaving the area, occupancy sensor keeps luminaires on for a set time delay (20-minutes). If no occupants are detected over the course of the time delay, the lights controlled by the sensor shall be turned off.

4. Upon occupancy sensor detection of occupants re-entering the area, luminaires output shall be automatically turned back up to 100%.

5. Sequence then repeats.

D. Exterior Lighting:

1. Luminaires shall automatically turn off when daylight is present and satisfies the lighting needs.

2. All other exterior lighting shall be controlled so that the total lighting is automatically reduced by not less than 30% by selectively switching off or dimming luminaires at one of the following times:

a. During any time where activity has not been detected for 15 minutes or more.

3. Luminaires serving outdoor parking areas having a rated input wattage of greater than 78W and a mounting height of 24ft or less above ground shall be controlled by automatically reducing the power of each luminaire by a minimum of 50% when no activity is detected in the area illuminated by the controlled luminaires for a time of no longer than 15 minutes. No more than 1500W of lighting power shall be controlled together.

2.0 PART 2 - PRODUCTS

2.1 ROOM CONTROLLERS

A. Modular, stand-alone one room lighting control system (0-10V dimming and switching) with control of multiple user presets and room occupancy and daylight sensing for daylight harvesting.

B. Concealed mounting, self-contained, multi-channel lighting controller designed to communicate with occupancy and photo sensor inputs without the use of external power packs.

C. Shall allow for on-site commissioning controls via an infrared handheld remote control.

D. Lighting loads: Refer to floor plans for quantity of lighting channels per room. Where any room exceeds three channels, provide multiple room controllers networked together for proper system operation.

E. Multiple room controllers connected together in a local network must automatically arbitrate with each other, without requiring any configuration or setup, so the individual load numbers are sequentially assigned using each controller's device ID's from highest to lowest.

F. Each load shall at minimum be configurable to operate in the following sequences based on occupancy:

1. Auto-on/Auto-off

2. Manual-on/Auto-off

G. Manual override and LED indicated for each load.

H. Compatible with 120/277 VAC systems.

I. Maximum 20A combined 20A combined load per Room Controller.

J. All digital parameter data programmed into each room controller shall be retained in non-volatile FLASH memory within the controller itself. Memory shall have an expected life of no less than 10 years.

K. Room controller shall include:

1. Real time current monitoring

2. Efficient 250 mA switching power supply

3. RJ-45 network ports with integral strain relief and dust covers

4. One dimming output per relay

a. The 0-10-volt output shall automatically open upon loss of power to the Room Controller to assure full light output from the controlled lighting.

b. Each dimming output channel shall have an independently configurable minimum and maximum calibration trim level to set the dimming range to match the true dynamic range of the connected driver. The LED level indicators on connected dimmer switches shall utilize this new maximum and minimum trim.

c. Each dimming output channel shall have an independently configurable minimum and maximum trim level to set the dynamic range of the output within the new 0—100% dimming range defined by the minimum and maximum calibration trim.

d. Calibration and trim levels must be set per output channel.

e. All configuration shall be digital. Devices that set calibration or trim levels per output channel via trim pots or dip-switches are not acceptable.

5. Fade rates for dimming loads shall be specific to connected switch buttons, and the load shall maintain a default value for any connected buttons that do not specify a unique value.

L. Class 2 dimming control signal: 0-10VDC, sinks up to 100mA per channel for control of compatible drivers.

M. UL 2043 Plenum rated.

N. IR window built-in to room controller for commissioning with remote control.

O. Provide (1) infrared remote control for startup, programming, and commissioning.

P. Provide with digital input/output interface that includes an isolated relay with N/O and N/C outputs; rated for 1 Amp @ 30 VDC/VAC.

Q. Five year warranty.

R. Design Make: Wattstopper LMRC-210 Series with LMIN-104 Digital I/O Interface

S. Approved Equivalents:

1. Crestron ZUM Series

2. Current NX Lighting Controls FX Series

3. Acuity nLight RPP20 series

4. Leviton IRC Series

2.2 LOW-VOLTAGE SWITCHES FOR ROOM CONTROLLERS:

A. Low-Voltage Switch

1. On/Raise & Off/Lower dimming control button with led status indicator

2. Dimming switch with seven bi-level LED’s to indicate load levels using 14 steps.

3. Two-way infrared (IR) transceiver for use with personal and configuration remote controls.

4. All digital parameter data programmed into each wall switch shall be retained in non-volatile FLASH memory within the controller itself. Memory shall have an expected life of no less than 10 years.

5. Two RJ-45 ports for connection to the Room Controller network and other devices.

6. Multiple digital wall switches may be installed in a room by simply connecting the to the room controller network. No additional configuration shall be required to achieve multi-level switching.

7. Ramp rate may be adjusted for each dimmer switch.

8. Color by Architect.

9. Five-year warranty.

10. Shall be of the same manufacturer as the room controller.

11. Design Make: Wattstopper LMDM-101 Series

12. Acceptable Manufacturer's:

    a. Crestron

    b. Current NX

    c. nLight

    d. Leviton

2.3 OCCUPANCY SENSORS

A. General:

1. All occupancy sensor layouts have been done using the "design make" sensors. The contractor shall be responsible for providing additional sensors and all associated equipment required to provide coverage for required areas.

B. Wall Mounted Sensors

1. Switchbox type (single circuit):

    a. 120-277 volt, 1000/1200 watts

    b. 1000 sq. ft. of coverage major motion, 300 sq. ft. of coverage minor motion, 180 degree viewing angle.

    c. Passive infrared technology.

    d. Adjustable time delay from 5 minutes to 30 minutes.

    e. Adjustable sensitivity from 20% to 100%.

    f. Manual on switch operation (vacancy mode).

    g. Internal photocell.

    h. Decorator style, ivory color.

i. Install in single gang switch box.

j. Design Make: Wattstopper WS-301 series.

k. Acceptable Manufacturers:

1) Crestron Steinel

2) Current NX Controls

3) nLight Controls

4) Leviton

2. Switchbox Dimming Type (single circuit):

a. 120-277 volt, 1000/1200 watts

b. 900 sq. ft. of coverage, 180 degree viewing angle, passive infrared technology.

c. Adjustable time delay from 30 seconds to 30 minutes.

d. Adjustable sensitivity from 20% to 100%.

e. Manual on switch operation (vacancy mode).

f. Decorator style, white color.

g. Install in single gang switch box.

h. Internal photocell.

i. Design Make: Wattstopper DW-311 series

j. Acceptable Manufacturers:

1) Crestron Steinel

2) Current NX

3) nLight

4) Leviton

3. Switchbox type (two circuit):

a. 120-277 volt, 800/1200 watts

b. 600 sq. ft. of coverage, 180 degree viewing angle.

c. Passive infrared technology.

d. Adjustable time delay from 30 seconds to 30 minutes.

e. Adjustable sensitivity from 20% to 100%.

f. Two manual on switches for independent control of two separate circuits.

g. Decorator style, ivory color.

h. Install in single gang switch box.

i. Design Make: Wattstopper PW-302 Series

j. Acceptable Manufacturers:

1) Crestron Steinel

2) Current NX

3) nLight

4) Leviton

C. Ceiling Mounted Sensors

1. Type OS-A Ceiling Mounted Sensors

a. Minimum 450 square feet of coverage, 360 degree viewing angle.

b. Passive infrared technology. Adjustable sensitivity.

c. Adjustable time delay from 5 to 30 minutes.

d. Install semi-flush in single gang switch box above the ceiling.

e. Standalone Sensors:

1) Includes an isolated relay with N/O and N/C outputs; rated for 1 Amp @ 30 VDC/VAC

2) Provide with relay power packs compatible with manual on operation and day-light operation and multi-level switching as shown on drawings.

3) Compatible with optional low voltage switch for manual-on operation.

4) Design Make: Wattstopper CI-300

5) Approved Equivalents:

a) Crestron Steinel

b) Current NX

c) Sensor Switch

d) Leviton

f. Sensors connected to Room Controllers:

1) Two RJ-45 ports for connection to the Room Controller and other devices.

2) Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool and control by remote personal controls.

3) Load parameters including automatic/manual-on, blink warning, and daylight enable/disable when photo sensors are also connected to the Room Controller.

4) Shall be of the same manufacturer as the Room Controller

5) Design Make: Wattstopper LMPC-100 Series

6) Acceptable Manufacturers:

a) Crestron Zum

b) Current NX

c) nLight

d) Leviton

2. Type OS-B Ceiling Mounted Sensors

a. Minimum 1,000 square feet of coverage, 360 degree viewing angle.

b. Dual technology (Ultrasonic/PIR or Microphonic/PIR). Field selectable for either setting or both. Adjustable sensitivity.

c. Adjustable time delay from 5 to 30 minutes.

d. Installs surface mounted in 4” octagon J-box above the ceiling.

e. Standalone Sensors:

1) Includes an isolated relay with N/O and N/C outputs; rated for 1 Amp @ 30 VDC/VAC

2) Provide with relay power packs compatible with manual on operation and day-light operation and multi-level switching as shown on drawings.

3) Compatible with optional low voltage switch for manual-on operation.

4) Design Make: Wattstopper DT-300

5) Approved Equivalents:

a) Crestron Steinel

b) Current NX

c) Sensor Switch

d) Leviton

f. Sensors connected to Room Controllers:

1) Two RJ-45 ports for connection to the Room Controller and other devices.

2) Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool and control by remote personal controls.

3) Load parameters including automatic/manual-on, blink warning, and daylight enable/disable when photo sensors are also connected to the Room Controller.

4) Shall be of the same manufacturer as the Room Controller

5) Design Make: Wattstopper LMDC-100 Series

6) Acceptable Manufacturers:

a) Crestron Zum

b) Current NX

c) nLight

d) Leviton

3. Type OS-B Wall Mounted Sensors

a. Minimum 2,000 square feet of coverage when installed at 10-foot above floor, 90 degree viewing angle.

b. Dual technology (Ultrasonic/PIR or Microphonic/PIR). Field selectable for either setting or both. Adjustable sensitivity.

c. Adjustable time delay from 5 to 30 minutes.

d. Adjustable knuckle for angling sensor dependent on space configuration

e. Installs surface mounted in 4” square J-box above the ceiling.

f. Sensors connected to Room Controllers:

1) Two RJ-45 ports for connection to the Room Controller and other devices.

2) Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool and control by remote personal controls.

3) Load parameters including automatic/manual-on, blink warning, and daylight enable/disable when photo sensors are also connected to the Room Controller.

4) Shall be of the same manufacturer as the Room Controller

5) Design Make: Wattstopper LMDX-100 Series

6) Acceptable Manufacturers:

a) Crestron Zum

b) Current NX

c) nLight

d) Leviton

4. Type OS-C Ceiling Mounted Sensors

a. Nominal 10’ X 75’ of coverage for corridors.

b. Ultrasonic technology.

c. Adjustable time delay from 30 seconds to 15 minutes.

d. Adjustable sensitivity.

e. Manual sensor bypass.

f. Install surface mounted in single gang switch box above the ceiling.

g. Provide with relay power pack.

h. Design make: Wattstopper UT-300 series

i. Acceptable Manufacturers:

1) Crestron Steinel

2) Current NX

3) Sensor Switch

4) Leviton

5. Type OS-D High Bay Ceiling Mounted Sensors

a. Suitable for ceiling heights up to 40-feet, maximum 100-foot diameter coverage

b. 360 degree viewing angle.

c. Passive infrared technology. Adjustable sensitivity.

d. Provide with backbox, sensor module and lens

e. Adjustable time delay from 5 to 30 minutes.

f. Install surface mounted to structural steel.

g. Standalone Sensors:

1) Includes an isolated relay with N/O and N/C outputs; rated for 1 Amp @ 30 VDC/VAC

2) Provide with relay power packs compatible with manual on operation and day-light operation and multi-level switching as shown on drawings.

3) Compatible with optional low voltage switch for manual-on operation.

4) Design Make: Wattstopper HB3XO Series with HBL7 Lens

5) Approved Equivalents:

a) Crestron Steinel

b) Current NX

c) Sensor Switch

d) Leviton

2.4 PHOTO SENSOR

A. Digital daylighting sensor shall work with the Room Controllers describe in this section to provide automatic dimming daylight harvesting capabilities.

B. Continuously monitors daylight entering window or skylight to enable daylight harvesting applications to provide control of room lighting based on presence of daylight.

C. Shall provide the option, when daylight contribution is sufficient, of turning the lights off or dimming the lights to a field-selectable minimum level.

D. Shall have a digital, independently configurable fade rate for both increasing and decreasing light level in units of percent per second.

E. Shall provide adjustable cut-off time. Cut –off time is defined by the number of selected minutes the load is at the minimum output before the load turns off. Selectable range between 0-240 minutes including option to never cut-off.

F. Wall switch override shall allow occupants to control lighting level with dimming wall switches.

G. Automatically establishes application specific set points following manual calibration using a wireless configuration tool or PC with appropriate software. For switching operation, an adequate deadband between the ON and OFF set points for each zone shall prevent the lights from cycling; for dimming operation, a proportional control algorithm shall maintain the design lighting level in each zone.

H. Install in location recommended by the manufacturer.

I. Field of View: 60 Degree cone.

J. Sensitivity: 1-6,553 foot-candles (10-70,536 lux).

K. LED status and configuration indicators.

L. Infrared (IR) transceiver for configuration and/or commissioning with a handheld configuration tool, to transmit detected light level to wireless configuration tool.

M. One RJ-45 port.

N. Connects to room controller via Cat.5e patch cable without the need for external power packs.

O. Five year warranty.

P. Shall be of the same manufacturer as the room controller.

Q. Design Make: Wattstopper LMLS-500 Series

R. Acceptable Manufacturers:

1. Crestron

2. Hubbell

2.5 TIME SWITCHES (CLOCKS)

A. Astronomical time switch.

B. Time switch controls for exterior lighting shall comply with the following:

1. They shall have a clock capable of being programmed for not fewer than 7 days.

2. They shall be capable of being set of seven different day types per week.

3. They shall incorporate an automatic holiday setback feature.

4. They shall have program backup capabilities that prevent the loss of program and time setting for a period of not less than 10 hours in event that power is interrupted.

C. Input voltage shall be 120/277v.

D. Shall have (2) sets of contacts rated for 30A each.

E. Program backup capabilities to prevent loss of program for a period of not less than 10 hours when power is interrupted.

F. NEMA 3R Enclosure if mounted outdoors.

G. Design Make: Tork-NSI DZS series.

H. Acceptable Manufacturers:

1. Tork-NSI

2. Intermatic

2.6 LOW-VOLTAGE WIRING FOR LIGHTING CONTROLS

A. 0-10VDC Wiring

1. UL Type CMP plenum rated cable

2. 0-10VDC wiring shall be white outer jacket with 2-conductor purple and gray jacket insulation on the internal 18AWG solid copper conductors.

3. Design Make: Liberty AV Solutions 18-2C-LVBP-WHT or Approved Equal

B. Unshielded Twisted Pair (UTP) Wiring

1. UL Type CMP plenum rated cable

2. RJ-45 factory terminated RJ-45 connectors

3. ANSI/TIA-568-C.1 certified Cat. 6 Cable

4. Max. length 100-meters

5. Design Make: Belden, West Penn Wire, Hubbell, Leviton

3.0 PART 3 - EXECUTION

3.1 EXAMINATION:

A. Examine areas and conditions, under which luminaires are to be installed, and substrate for supporting luminaires. Notify Architect in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 PRE-INSTALLATION MEETING

A. A factory authorized manufacturer’s representative shall provide the electrical contractor a functional overview of the lighting control system prior to installation. The contractor shall schedule the pre-installation meeting after receipt of approved submittals to review the following:

1. Confirm the location and mounting of all digital lighting control devices, with special attention to placement of occupancy and photo sensors.

2. Review the requirements for low-voltage control wiring and termination.

3. Discuss the functionality and configuration of all products, including sequences of operation, per design requirements.

3.3 COORDINATION

A. Refer to respective reflected ceiling plan for each area. Reflected ceiling plans indicate proper luminaire location only. Locate occupancy sensors and photo sensors per the manufacturer’s recommendations. Coordinate the proper arrangement with all other ceiling mounted items. Contract Documents indicate luminaire characteristics (type), quality, quantity, etc. Verify with the ceiling supplier design of actual ceiling installed in each area and coordinate compatible luminaire flange/trim type.

B. General

1. Install interior lighting controls at locations and heights as indicated, in accordance with luminaire manufacturer's written instructions, applicable requirements of NEC, NECA's 'Standard of Installation", NEMA standards, and with recognized industry practices.

2. Make installation such that the lighting controls are free of finger marks, flaws, scratches, dents or other imperfections.

3.4 DELIVERY, STORAGE, AND HANDLING

A. Luminaires and equipment shall be delivered with UL and manufacturer's labels intact and legible in factory fabricated containers.

B. Luminaires and accessories shall be stored in protected dry locations in their original unbroken package or container. Luminaires shall be protected from dust and dampness both before and after installation. Luminaires shall be protected from paint and cleaning solvents during all phases of construction.

C. Handle interior lighting luminaires carefully to prevent damage, breaking, and scoring of finishes. Do not install damaged luminaires or components; replace with new.

3.5 SEQUENCING AND SCHEDULING

A. Coordinate with other work including ceiling type, wires/cables, electrical boxes, fittings, and raceways, to properly interface installation of interior luminaires with other trades.

B. The contractor shall provide the lighting control systems manufacturer with three weeks written notice of the system startup and adjustment date.

3.6 OCCUPANCY SENSORS

A. Provide all necessary mounting brackets, wiring, low voltage transformers and control relays required to provide control of areas indicated.

B. Provide initial time delay and sensitivity settings per owner's representative.

C. Install in location as recommended by the manufacturer.

D. Refer to "Lighting System Functional Testing" part of this section for additional information.

3.7 PHOTO SENSORS

A. For calibration of photosensor, contractor shall use handheld digital light meter measuring device in the 0-200 foot-candle range. Provide adjustments to threshold on sensor to meet user requirements. Initial foot-candle threshold setting to automatically turn off lights shall be 50 foot-candles. Provide adjustments to meet owner requirements and space constraints.

B. Install in location as recommended by the manufacturer.

C. Refer to "Lighting System Functional Testing" part of this section for additional information.

3.8 CONTROL WIRING

A. Provide all required low-voltage control wiring for lighting control system components.

B. Provide RJ-45 factory terminated Cat. 6 or better Unshielded Twisted Pair (UTP) cable with RJ-45 connectors to connect switching, photo control, and occupancy sensing devices on the Room Controller network. Cables shall manufacturer approved for the connectivity solution.

C. Provide 0-10VDC wiring for dimming from Room Controller and dimming switches to the drivers.

D. Control Wiring Installation:

1. All interior cabling shall be installed concealed inside the wall cavities and ceiling space.

2. Provide a continuous raceway system in accordance with NEC Article 800 for horizontal cable runs through all inaccessible ceiling (including drywall) and wall cavity spaces. All flexible raceway system runs shall be securely attached to ceiling joists and wall studs 3-feet O.C and removal and addition of cables in the future.

3. UTP Cables shall be supported by Cable Hangers 3-foot on center. When installed in cable tray zip-tie to cable tray away from STP, coaxial cables, and optical fiber cables. Provide additional stacked Cable Hangers when filled greater than 50%.

3.9 LIGHTING SYSTEM FUNCTIONAL TESTING

A. Lighting system functional testing shall comply with the following requirements:

1. Provide plan markup which indicates the exact location of each sensor, direction of aim, and certify on the plan that the direction of aim and placement are in compliance with manufacturer's requirements. Include this plan with the Operation & Maintenance Manuals.

2. Occupancy Sensor Controls:

a. Certify that the occupancy sensor has been located and aimed in accordance with the manufacturer's recommendations.

b. All devices shall be tested. Verify the following:

1) Where occupant sensor controls include status indicators, verify correct operation.

2) The controlled lights turn off or down to the permitted level within the specified time.

3) The lights turn on only when manually activated.

4) The lights are not incorrectly turned on by movement in adjacent areas or by HVAC operation.

3. For Time – Switch Controls:

a. Verify that timers are properly programmed with weekday, weekend and holiday schedules.

b. Provide documentation to the Owner of time-switch controls programming including weekday, weekend, and holiday schedules and set-up and preference program settings. Include a copy in testing documentation package for approval by the Engineer.

c. Verify time of day and day of week are properly set.

d. Verify that any battery back-up is installed and energized.

e. Verify that any override timer is set for less than 2 hours.

f. Simulate occupied condition and verify the following:

1) All lights can be turned on or off by respective area control switch.

2) Light switches control only those lights in the enclosed area where the switch is located.

g. Simulate unoccupied condition and verify the following:

1) Non-exempt lights turn off.

2) Manual override switches allows only the lights in the enclosed space where the override switch is located to turn on or remain on until the next scheduled shutoff occurs.

h. For Daylight Responsive Controls:

1) Verify that the control sensing devices have been properly located, field calibrated and set for accurate control set points and threshold lighting levels.

2) Daylight controlled lighting loads adjust to light levels set points in response to available daylight.

3) The location of calibration adjustment equipment is readily accessible only to authorized personnel.

4) Record all set points and verify with calibrated light meter the actual field recorded lighting control levels.

5) Upon request, repeat measurements in the presence of the Design Professional or their authorized representative to validate lighting level control response.

4. Create a log of deficiencies noted during testing. Correct all deficiencies prior to project Commissioning Activity. Refer to Section 019113.

5. Provide records of all lighting system functional testing to the Commissioning Agent on the test form(s) provided within this section PRIOR to scheduled project functional testing.

6. Correct any deficiencies and discrepancies noted by the Commissioning Agent during their functional testing.

7. The Commissioning Agent will incorporate all final testing results into the project Commissioning Record.

B. Test Form:

1. Instruction: Contractor to complete either the following form or the form contained in the approved testing plan for each room in the project that receives lighting controls. Provide electronic copy of all completed testing forms and reports to the Commissioning Authority for their use.

Room Name/Number:	***Date:***	
Testing Agent's Name:		
Testing Agent's Signature:		
Testing Agent's Company & Position:		
Occupancy Sensor Controls	*Initials*	*N/A*
Verify that the occupancy sensor has been located and aimed in accordance with the manufacturer's recommendations such that occupants within the space properly trigger lighting operation without false trigger from adjacent areas.		
Verify that the status indicators on the occupancy sensor are operating correctly.		
Verify that the controlled lights turn OFF or down to the permitted level within the specified time.		
Verify that the controlled lights turn ON only when manually activated.		
Verify that the lights are not incorrectly turned on by movement in adjacent areas or by HVAC operation.		
Record sensitivity level and delay settings for occupancy sensor control:		
Time - Switch Controls	*Initials*	*N/A*
Verify that the timers are properly programmed with weekday, weekend, and holiday schedules.		
Record time schedule as programmed:		
Verify that the time of day and day of week are properly set.		
Verify that battery back-up is installed and energized.		
Verify that the override timer is set for less than 2 hours.		
Simulate occupied condition: I verify that all lights can be turned on or off by respective area control switch.		
Simulate occupied condition: I verify that the lighting switches control only those lights in the enclosed area where the switch is located.		
Simulate unoccupied condition: I verify that all non-exempt lights turn off.		
Simulate unoccupied condition: I verify that the manual override switch allows only the lights in the enclosed space where the override switch is located to turn on or remain on until the next scheduled shutoff occurs.		
Daylight Responsive Controls	*Initials*	*N/A*
Verify that the control sensing devices have been properly located, field calibrated, and set for accurate control set points and threshold lighting levels.		
Verify that the daylight controlled lighting loads adjust to light levels set points in response to available daylight.		
Verify that the location of calibration adjustment equipment is readily accessible only to authorized personnel.		
Record set point (foot-candles):		
Record lighting control level with calibrated light meter (foot-candles):		
Record cut-off time (minutes):		
Record fade rate (units/second):		

3.10 TRAINING

A. Upon completion of the system startup, the factory-authorized technician shall provide the proper training to the owner's personnel on the adjustment and maintenance of the lighting control system. Include sign in sheet with Operation & Maintenance Manuals.

3.11 WARRANTY

A. All lighting controls equipment included in this section shall be fully tested and guaranteed for a period of five years after Owner's Representative written acceptance.

END OF SECTION 260923

SECTION 262400 - SWITCHBOARDS AND PANELBOARDS

1.0 PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.

1.2 SCOPE

A. This section includes minimum requirements for the following:

1. Circuit Breakers

2. Branch Circuit Panelboards

1.3 QUALITY ASSURANCE

A. All low voltage power distribution equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the Contract Documents shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

B. Materials and installation practices specified herein shall comply with the applicable requirements of:

1. The following Articles of the National Electric Code (NFPA 70):

a. 240 - Overcurrent Protection

b. 368 - Busways

c. 404 - Switches

d. 408 - Switchboards and Panelboards

2. The following National Electrical Manufacturers Association (NEMA) Standards:

a. NEMA AB 1 1993 - Molded Case Circuit Breakers and Molded Case Switches

b. NEMA BU 1 - Busways

c. NEMA PB 1 - Panelboards

d. NEMA PB 1.1 - Instructions for Safe Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or less.

e. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)

f. NEMA 250 - Enclosures for Electrical Equipment

3. The following American National Standards Institute (ANSI) standards:

a. ANSI/NETA-2025 ATS for Electrical Power Equipment and Systems

b. ANSI C37 – Low-Voltage Power Operated Circuit Breakers

c. ANSI/IEEE C12.1 Code for Electric Metering

4. The following U.L. Standards:

a. UL 50 - Enclosures for Electrical Equipment

b. UL 67 - Panelboards

c. UL 98 - Enclosed and Dead-Front Switches

d. UL 489 - Molded Case Circuit Breakers and Circuit Breaker Enclosures

e. UL 857 - Underwriters Busway Standard

f. UL 891 – Standard for Switchboards

g. UL 943 - Standard for Ground Fault Circuit Interrupters

h. UL 1066 - Low-Voltage Power Operated Circuit Breakers

1.4 SUBMITTALS

A. Provide product data including voltage, current, interrupting rating, and enclosure type for the following:

1. Thermal Magnetic Molded Case Circuit Breakers

2. Branch Circuit Panelboards

1.5 MINOR MODIFICATIONS

A. Provide modifications to circuit breaker trip rating within the frame size at no additional cost, until shop drawings are reviewed and submitted.

1.6 FIELD SUPERVISION

A. Provide field supervision and start-up by a qualified representative of the equipment manufacturer. Provide certification that the equipment has been installed in accordance with the manufacturer’s requirements.

2.0 PART 2 - PRODUCTS

2.1 CIRCUIT BREAKERS

A. General

1. UL 489 listed.

2. Below 250Amps – Unless otherwise noted, operation shall be from a fixed thermal magnetic trip unit. Permanent trip unit containing individual thermal and magnetic trip elements.

3. 250Amps and above - Include field adjustable electronic Long Time, Short Time, and Instantaneous trip unit.

4. 400Amps and above - Include field installed interchangeable rating plugs.

5. Provide an over-center, trip-free handle to provide quick-make, quick-break contact action.

6. Provide multi-pole breakers with common trip.

7. When the circuit breaker has tripped, the handle shall move to a position between the “on” and “off” positions. Provide a visual indication that the circuit breaker has tripped.

8. The ampere rating shall be clearly marked on the face of the circuit breaker.

9. Series rated fuse/circuit breaker installations are not acceptable.

10. Make provisions to add circuit breaker handle locks.

11. Circuit breakers shall have voltage, ampere, and interrupting ratings as called for on the Panelboard Schedule.

12. New circuit breakers installed in existing panelboards shall be UL listed for use in panelboard and match or exceed interrupting ratings.

B. Thermal Magnetic Molded Case Branch Circuit Breakers

1. Molded case circuit breakers shall be constructed of a glass reinforced insulating material. All current carrying components shall be completely insulated and isolated from the outside of the circuit breaker.

2. 60°C terminal temperature rating for circuit breakers rated 125 amperes or below.

3. 75°C terminal temperature rating for circuit breakers rated above 125 amperes.

4. All 20 and 30 ampere, single pole circuit breakers shall be UL listed for switching duty.

5. Circuit breakers shall be bolt-on. Plug-on acceptable in load centers on residential applications only.

6. Circuit breakers rated 250 amperes and below shall be UL listed HACR type.

7. Where ground fault circuit breakers are required, provide a shunt trip circuit breaker with a zero sequence sensing ground fault module.

8. Design Make: Square D QOB (250 volt), EH, EHB (480 volt), I-Line style (600 volt).

9. Acceptable Manufacturers:

   a. ABB

   b. Eaton

   c. Siemens

   d. Square D

C. Arc Mitigation and Safety Options

1. Shall be provided on all circuit breakers 1200 Amps or larger.

2. Alternate Maintenance Setting Switch (AMS).

3. Designed for the temporary arc-flash incident energy reduction during maintenance activities.

4. For each feeder circuit breaker, provide a manual switch on the compartment door to switch the circuit breaker short-time tripping characteristics to instantaneous with minimum pick-up setting, in order to reduce the danger from potential arc-flash at downstream equipment.

5. Provide a lock feature for the AMS switch so that it may be locked in either the Off or On maintenance mode position.

6. Provide a blue LED indicating light to indicate AMS switch is in the maintenance mode.

7. Wire contacts on all AMS switches to a common alarm input to plant control system.

8. Provide for remote AMS switches or indication, as needed.

9. If circuit breaker integral trip unit cannot be controlled as specified, provide discrete relay with shunt-trip or equivalent to provide specified performance.

2.2 BRANCH CIRCUIT PANELBOARDS

A. 240 Volt rated, maximum 400 amperes.

B. Copper bus bars with high dielectric thermoplastic insulators.

C. Provide continuous current ratings, short circuit current ratings, branch circuit breakers, main circuit breaker or main lugs, and flush or surface trims as called for on the Panelboard schedule.

D. Provide nameplate on each panelboard indicating voltage, current, phase, wire, and short circuit rating.

E. 100% rated neutral of the same material as the main bus.

F. Provide ground bus of the same material as the main bus.

G. Interior trim shall be dead front construction, with pre-formed metal twist-outs covering unused mounting space.

H. Enclosures shall be nominal 20” wide by 6” deep, galvanized steel construction with removable end walls and knockouts.

I. Fronts

1. Surface or flush mounted as called for on the Panelboard Schedule.

2. ANSI 49 gray electrodeposited enamel.

3. Fronts shall be one piece with door, and continuous hinge to the enclosure.

4. Provide cylindrical tumbler type lock with catch and spring loaded stainless steel door pull. All locks shall be keyed alike.

5. Provide a clear plastic directory card holder on the inside of the door.

J. Design Make: Square D NQ Series

K. Acceptable Equivalents:

1. Eaton Pow-R-Line Series

2. ABB ReliaGear Series

3. Siemens P1 Panelboard Series

3.0 PART 3 - EXECUTION

3.1 GENERAL

A. Provide identification for all equipment and devices as indicated in section 260100.

B. Provide miscellaneous bolts, washers, nuts, clips, lockwashers, hardware, etc. as required to install equipment.

C. Unload, move, handle, set in place, install, erect, assemble, connect, test etc. all items ad required.

D. Provide minimum NEC working clearance for all equipment.

E. Verify cable/lug sizes for terminations. Where a feeder is sized larger the lug provide replacement lug or in line splice as directed by Owner's Representative.

3.2 CIRCUIT BREAKERS

A. Install circuit breakers in panelboards and switchboards as called for on the plans and as recommended by the manufacturer.

B. Adjust circuit breaker pick-up level and time delay settings to the values called for on the drawings indicated in the coordination study designated by the Engineer.

C. Submit documentation that a qualified representative from the equipment manufacturer has inspected and approved the installation.

3.3 BRANCH CIRCUIT AND DISTRIBUTION PANELBOARDS

A. Securely support all panelboard enclosures to walls. Install true and level.

B. Install panelboards with top of the highest circuit breaker handle at 6'-6" to the centerline.

C. Provide (5) five empty ¾" conduits and (1) one empty 1 ½" conduit from each flush mounted panelboard backbox to the accessible ceiling space. Make 90° turn above the ceiling, arranged for further continuation of raceway, and cap.

D. Make all branch circuit and feeder connections.

E. Provide channel support between the wall and backbox for panelboards installed on outside walls.

F. Tighten all bolt and lug connections using a torque wrench or screwdriver per the manufacturer's recommendations.

G. Measure steady state load currents on each panelboard feeder. Rearrange branch circuits in the panelboard to balance the load within 20% of each other. Maintain proper phasing.

H. Provide identification as required per section 260100.

3.4 TESTING

A. Prior to energizing the electrical equipment provided, the contractor shall perform testing in accordance with specification section 260503.

END OF SECTION 262400

SECTION 262913 - SWITCHES, CONTACTORS AND MOTOR CONTROLLERS

1.0 PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.

1.2 SCOPE

A. This section includes minimum requirements for the following:

1. Disconnect Switches
2. Lighting Contactors
3. Motor Control Equipment

1.3 QUALITY ASSURANCE

A. All low voltage power distribution equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the Contract Documents shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

B. Materials and installation practices specified herein shall comply with the applicable requirements of:

1. The following Articles of the National Electric Code (NFPA 70)
    a. 240 - Overcurrent Protection
    b. 404 – Switches
    c. 430 – Motors, Motor Circuits, and Motor Controllers
2. The following National Electrical Manufacturers Association (NEMA) Standards:
    a. NEMA AB 1 1993 - Molded Case Circuit Breakers and Molded Case Switches
    b. NEMA PB 1.1 - Instructions for Safe Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or less.
    c. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)

d. NEMA 250 - Enclosures for Electrical Equipment

3. The following American National Standards Institute (ANSI) standards:

a. ANSI/IEEE C12.1 Code for Electric Metering

4. The following U.L. Standards:

a. UL 50 - Enclosures for Electrical Equipment

b. UL 98 - Enclosed and Dead-Front Switches

1.4 SUBMITTALS

A. Provide product data including voltage, current, interrupting rating, and enclosure type for the following:

1. Disconnect Switches

2. Lighting Contactors

3. Motor Control Equipment

1.5 FIELD SUPERVISION

A. Provide field supervision and start-up by a qualified representative of the equipment manufacturer. Provide certification that the equipment has been installed in accordance with the manufacturer's requirements.

2.0 PART 2 - PRODUCTS

2.1 DISCONNECT SWITCHES

A. Three pole, single throw, or as called for on the drawings.

B. Quick-make, quick-break switch operating mechanism.

C. Mechanical service life (switching cycles) / typical: 10000

D. Heavy duty, 600VAC rated, current rating as called for on the drawings.

E. Defeatable dual cover interlock external override mechanism to open the disconnect switch door without opening the disconnect switch.

F. All current carrying parts shall be plated to resist corrosion.

G. Lugs shall be removable and rated for 75°C temperature rating.

H. Switch blades shall be visible when the switch is in the open position and the door is open.

I. Switch shall be padlockable in the OFF and ON positions.

J. Provide fusible switches with rejection type fuse holders and fuses as indicated on the plans or as per fed equipment requirements.

K. Enclosure shall be steel with gray baked enamel paint unless otherwise noted on the drawings.

L. Provide NEMA type enclosures as called for on the drawings. Unless otherwise noted, all rooftop and exterior switches shall be NEMA type 3R.

M. NEMA type 1 enclosures shall be equipped with knockouts.

N. Design Make: Square D

O. Acceptable Manufacturers:

1. ABB

2. Eaton

3. Siemens

4. Square D

2.2 MOTOR CONTROL EQUIPMENT

A. General

1. Provide motor starters, disconnect switches, etc., as listed on the Electric Equipment and Control Schedule on the drawings.

2. Starters, contactors and controllers shall comply with NEMA standards having general purpose NEMA 1 or 1B enclosure unless otherwise called for. Provide explosion proof, weather resistant or watertight construction as required. Starters shall be minimum NEMA size 0 with overloads in each phase sized per NEC, nameplate motor full load amperage, service factor, and motor operating conditions.

3. Pad lock arrangements shall be provided to lock the disconnect device in the "off" position. Magnetic starters shall be provided with a control power transformer with 120V secondary and primary and secondary fusing and be sized to accept the loads imposed there on. Starters shall have transformer type pilot lights and 6 volt long life bulbs. Each starter subject to electrical interlock and/or automatic control shall have necessary auxiliary contacts.

4. Auxiliary devices: Provide pushbutton stations, pilot lights, devices, relays, transformers, selector switches, electric thermostats, auxiliary starter contacts as required for functions called for. Provide separate relay for each speed to operate electric dampers or other devices as required for multispeed motor circuit.

5. Manual Motor Starter: Provide all starters with thermal overload(s); and pilot light(s), and handle lock-out provisions. Gang starter with selector switch for multispeed applications. Provide single or 2-pole as required:

   a. 120 volt, single-pole, surface mounted: Square-D FG-1P.

   b. 120 volt, single-pole, flush mounted: Square-D FS-1P.

   c. 240 volt, two-pole, surface mounted: Square-D FG-2P.

   d. 240 volt, two-pole, flush mounted: Square-D FS-2P.

   e. 120 volt, single-pole, two speed, surface mounted: Square-D FG-11P.

   f. 120 volt, single-pole, two speed, flush mounted: Square-D FS-101P.

   g. 240 volt, two-pole, two-speed, surface mounted: Square-D FG-22P.

   h. 240 volt, two-pole, two-speed, flush mounted: Square-DFS-202P.

   i. 120 volt, single-pole, H-O-A selector, surface mounted: Square-D FG-72P.

   j. 120 volt, single-pole, H-O-A selector, flush mounted: Square-D FS-72P.

   k. 240 volt, two-pole, H-O-A selector, surface mounted: Square-D FG-72P.

   l. 240 volt, two-pole, H-O-A selector, flush mounted: Square-D FS-72P.

   m. 120 volt, single-pole, surface mounted, explosion proof: Square-D FR-1H.

   n. 240 volt, two-pole, surface mounted, explosion proof: Square-D FR-2H.

   o. Manual Motor Starter - Speed Controller: Shall be similar to "Manual Motor Starter", above, except two-gang with motor speed control sized to handle motor indicated, with positive full on and full off bypass of speed control unit.

6. Manual Starter with Relay: Shall be similar to "Manual Motor Starter", above, except two-gang with relay sized for load indicated, and hand-off-automatic switch. Connect relay for 120V operation on load side of starter in "automatic" mode. Coordinate connection of Form C maintained contact for control with Mechanical Contractor.

B. Magnetic Starters

1. Shall be single-speed, across-the-line type rated in accordance with NEMA standards, sizes and horsepower ratings.

2. Starters shall be mounted in NEMA 1 enclosures unless otherwise indicated.

3. Magnetic starters shall be equipped with double break silver alloy contacts; all contacts shall be replaceable without removing starter or disconnecting power wiring.

4. Starter shall have straight-through wiring. Coils shall be of molded construction and shall be replaceable from the front without removing starter.

5. Overload relays shall be melting alloy type with replaceable control circuit module. Thermal units shall be of one-piece construction and interchangeable. Starter shall be inoperative if thermal unit is removed.

6. Provide hand-off-auto selector switch**,** start-stop pushbuttons and "run" pilot light in cover. Wire for maintained contact unless otherwise noted.

C. Combination Magnetic Starter: Shall be similar to "Magnetic Starter", above, except shall include circuit breaker disconnect switch connected ahead of starter. The disconnect handle shall be in control of the disconnect device with the door open or closed. Disconnect handle shall be clearly marked as to whether the disconnect device is "on" or "off".

D. Combination Two-Speed Magnetic Starter: Shall be similar to "Combination Magnetic Starter", above, except with two starters, and six thermal overload units coordinated to match torque and horsepower characteristics of the motor. Starter shall be designed for variable torque operation, and shall be provided with high-low-off-auto selector switch and high and low pilot lights mounted in the cover. Wire for maintained contact unless otherwise noted.

E. Combination Reduced Voltage Magnetic Starter: Shall be similar to "Combination Magnetic Starter", above, except auto-transformer closed transition reduced voltage type with auto-transformer protection by winding over-temperature device.

F. Packaged Control Unit: Shall be furnished under Division 22 or 23, and connected by Electrical Contractor. Generally consists of one or more starters, disconnect switches and additional control devices prewired.

G. Contactor: Shall be similar to "Magnetic Starter", above, except without thermal overload units.

H. Design Make: Square D Class 8XXX

I. Acceptable Manufacturers:

1. ABB

2. Eaton

3. Siemens

4. Square D

2.3 LIGHTING CONTACTORS

A. 480V rated contacts, minimum of 30A or larger rating as called for on the drawings.

B. Electrically operated, electrically held.

C. Provide with 120V coil.

D. Provide with NEMA 1 enclosure or enclosure type if specified otherwise on drawings.

E. Provide with number of poles as called for on the drawings.

F. Shall be field convertible for NO/NC operation.

G. Design Make: Square D Class 8903

H. Acceptable Manufacturers:

1. ABB
2. Eaton
3. Siemens
4. Square D

3.0 PART 3 - EXECUTION

3.1 GENERAL

A. Provide identification for all equipment and devices as indicated in section 260100.

B. Provide miscellaneous bolts, washers, nuts, clips, lock washers, hardware, etc. as required to install equipment.

C. Unload, move, handle, set in place, install, erect, assemble, connect, test etc. all items ad required.

D. Provide minimum NEC working clearance for all equipment.

E. Verify cable/lug sizes for terminations. Where a feeder is sized larger the lug provide replacement lug or in line splice as directed by Owner's Representative.

3.2 DISCONNECT SWITCHES

A. Install disconnect switches in locations shown on plans. Install true and level.

B. Tighten all bolt and lug connections using a torque wrench or screwdriver per the manufacturer's recommendations.

C. Provide identification as required per Section 260100.

D. Provide fuses in all fusible switches.

E. All roof mounted disconnect switches shall be a minimum NEMA 3R rating.

F. Provide stainless steel hardware strut channel racking for all roof mounted disconnect switch supports. Do not install disconnect switches on roof curbs below the roof flashing level. Maintain roof warranty for all disconnect switch and associated raceway support installations.

G. Disconnect switches may be mounted to HVAC equipment where approved by the equipment manufacturer and not interfere with access panel or internal components.

3.3 MOTOR CONTROL EQUIPMENT

A. Provide overload and fuses. Coordinate sizes with Division 22 or 23 contractor.

B. Terminate control wiring. Coordinate with Division 22 or 23 contractor.

C. Prior to releasing the starter and disconnect order the Division 26 contractor shall obtain verification in writing from the Division 22 and 23 contractors that all starter and disconnect sizes and types are correct. The Division 26 contractor shall bear all cost if written approval is not obtained prior to releasing the order and size changes are required.

END OF SECTION 262913

SECTION 262923 – ADJUSTABLE-SPEED DRIVES

1.0 PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.

B. All Adjustable Speed Drives will be furnished and installed by the Electrical contractor. The Electrical contractor shall provide all internal control wiring jumpers, communication card installation and network settings communicate with the temperature control system, overload settings, and factory startup.

C. The Division 22 and 23 contractors will furnish all adjustments and programming temperature controls system settings and sequences.

1.2 SCOPE

A. This section includes minimum requirements for variable speed motor controls referred to as Adjustable Speed Drives (ASD) also referred to as Variable Frequency Drives (VFD) or Variable Speed Drives (VSD).

B. The drive manufacturer shall supply the drive and all necessary options as specified. All drives installed on this project shall be from the same manufacturer and have a common user interface (control panel). The manufacturer shall have been engaged in the production of this type of equipment for a minimum of 15 years. Drives that are manufactured by a third party and “brand labeled” shall not be acceptable. Drive manufacturers who do not build their own power boards and assemblies, or do not have full control of the power board manufacturing and quality control, shall be considered as a “brand labeled” drive.

C. This specification is a supplement to the drive schedule. The drive schedule identifies the specific requirement for each drive instance on the project including size, voltage, enclosure rating, disconnecting means, and harmonic mitigation requirements of the drives.

D. This section includes minimum requirements for the following:

1. Standard Adjustable Speed Drives

1.3 RELATED SECTIONS

A. Specification Section 260503 – Testing

1.4 QUALITY ASSURANCE

A. All adjustable speed drives shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the Contract Documents shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

B. Each drive shall be subjected to the following test and quality control procedures.

1. Each new product design shall undergo a 4000-hour pre-production burn-in test. A minimum of ten units shall be used to accumulate this entire time. Each unit shall be temperature cycled between 32 and 100 degrees Fahrenheit.

2. Every ASD shall be functionally tested under motor load. During this load test the ASD shall be monitored for correct phase current, phase voltages, and motor speed. Correct Current Limit operation shall be verified by simulating a motor overload. Manufacturing test data on each drive shall be recorded and stored by the manufacturer.

3. Verification of proper factory presets shall performed on 100% of all parameters to ensure proper microprocessor settings. Verification that the proper factory settings are loaded correctly in the drive shall be done via the drive serial interface port. Any parameter changes that are required after the addition of options such as communication cards or bypass shall be verified in addition to the drive only defaults.

4. All options shall be functionally tested including operation of a motor in the bypass mode if supplied. Proper sizing and adjustment of the integral motor overload shall be set and verified.

C. Referenced Standards and Guidelines:

1. Institute of Electrical and Electronic Engineers (IEEE)

a. IEEE 519-2014, IEEE Recommended Practice and Requirements for Harmonic Control in Electric Power Systems

2. Underwriters Laboratories

a. UL 508, 508A, 508C

b. UL 61800, 61800-5-1, 61800-5-2

c. UL 1995

3. The Association of Electrical Equipment and Medical Imaging Manufacturers (NEMA)

    a. NEMA ICS 7-2014, Adjustable Speed Drives

4. International Electrotechnical Commission (IEC)

    a. EN/IEC 61800

5. National Electric Code (NEC)

    a. NEC 430.120, Adjustable-Speed Drive Systems

6. CSA Group

    a. CSA C22.2 No. 274

D. Qualifications:

1. Drives shall be UL labeled as a complete assembly. The base ASD shall be UL listed for 100 kA SCCR when installed in accordance with the manufacturer's guidelines.

2. The base drive shall be SEMI-F47 certified. The drive must tolerate voltage sags to 50% for up to 0.2 seconds, sags to 70% for up to 0.5 seconds, and sags to 80% for up to one second.

1.5 SUBMITTALS

A. Provide a summary list of all ASD's with the following information:

1. Bill of materials.

2. Dimension drawings.

3. Wiring diagrams.

4. Product data sheets including:

    a. Integrated electrical protection.

    b. Agency certifications.

    c. Environmental tolerances.

    d. Electrical characteristics including harmonic performance

    e. Enclosure material and rating.

    f. Control (inputs, outputs, power supplies).

    g. Motor lead length @ 8 kHz carrier frequency.

5. List of all operator interface devices.

6. List of any exceptions to this specification.

1.6 START-UP SERVICE AND TRAINING

A. ASD's shall not be powered up without authorization from the ASD manufacturer. The contractor shall notify the ASD manufacturer when the units have been installed and shall schedule startup by a factory trained and authorized technician. This technician shall complete a startup report that records all ASD data, settings and a checklist of tests and observations. A copy of this test report shall be forwarded to the project Commissioning Authority and included in the Operation and Maintenance Manual.

B. The ASD factory trained, and authorized technician shall make all final adjustments as required for proper operation. Coordinate with the mechanical contractor and equipment vendors as required.

C. Provide one 2-hour training session on site by a ASD factory trained and authorized technician. This session shall review all operation and maintenance requirements plus the fundamentals of ASD's and their application to AC motors.

1.7 OPERATION AND MAINTENANCE MANUALS

A. Provide one copy of complete documentation for each type of adjustable speed drive installed. Documentation shall be bound and included in the Operation and Maintenance Manuals required in this Specification. Documentation shall include the following:

1. Wiring diagrams

2. Schematics

3. Operating and maintenance manuals

4. Local service representative

5. Emergency on sight technical support information

6. Recommended maintenance procedures

7. Recommended spare parts list

2.0 PART 2 - PRODUCTS

2.1 COMMON ADJUSTABLE SPEED DRIVE CAPABILITIES

A. The drive package as specified herein and defined on the drive schedule shall be enclosed in a UL Type enclosure (enclosures with only NEMA ratings are not acceptable), completely assembled and tested by the manufacturer to ISO9001 standards.

B. The drive shall provide full rated output from a line of +10% to -10% of nominal voltage. The drive shall continue to operate without faulting from a line of +25% to -25% of nominal voltage.

1. Drives shall be capable of continuous full load operation under the following environmental operating conditions:

1) Ambient temperature -15 to 40° C (5 to 104° F).

2) Altitude 0 to 1000 m (0 to 3,300 ft) above sea level.

3) Humidity 5 to 95%, non-condensing.

2. Supply Connection:

a. Voltage and power range:

1) 3-phase

2) Frequency: 48 to 63 Hz

3) Fundamental power factor: 0.98

4) Efficiency at rated power: 98%

3. Motor Connection:

a. Supported motor types:

1) Asynchronous motor

2) Permanent magnet motor

3) SynRm

b. Voltage:

1) 3-phase

2) From 0 to supply voltage

3) Frequency: 0 to 400 Hz

C. All drives shall utilize the same Advanced Control Panel (keypad) user interface.

1. Plain English text

a. The display shall be in complete English words for programming and fault diagnostics (alpha-numeric codes are not acceptable).

b. Safety interlock and run permissive status shall be displayed using predetermined application specific nomenclature, such as: Damper end switch, smoke alarm, vibration trip, and overpressure.

c. Safety interlock, run permissive, and external fault status shall have the option of additional customized project specific terms, such as: AHU-1 End Switch, Office Smoke Alarm, CT-2 Vibration.

2. The control panel shall include at minimum the followings controls:

a. Four navigation keys (Up, Down, Left, Right) and two soft keys to simplify operation and programming.

b. Hand-Off-Auto selections and manual speed control without having to navigate to a parameter.

c. Fault Reset and Help keys. The Help key shall include assistance for programming and troubleshooting.

3. Multiple Home View screens shall be capable of displaying up to 21 points of information. Customizable modules shall include bar charts, graphs, meters, and data lists. Displays shall provide real time graphical trending of output power, frequency, and current within selectable intervals of 15/30/60 minutes and 24 hours.

4. The control panel shall display the following items on a single screen; output frequency, output current, reference signal, drive name, time, and operating mode (Hand vs Auto, Run vs Stop). Bi-color (red/green) status LED shall be included. Drive (equipment) name shall be customizable.

5. There shall be a built-in time clock in the control panel. The clock shall have a battery backup with 10 years minimum life span. Daylight savings time shall be selectable.

6. I/O Summary display with a single screen shall indicate and provide:

a. The status/values of all analog inputs, analog outputs, digital inputs, and relay outputs. Drives that require access to internal or live components to measure these values, are not acceptable.

b. The programmed function of all analog inputs, analog outputs, digital inputs, and relay outputs.

c. The ability to force individual digital I/O high or low and individual analog I/O to desired value, for increased personal protection during drive commissioning and troubleshooting. Drives that require access to internal or live components to perform these functions, are not acceptable.

7. The drive shall automatically backup parameters to the control panel. In addition to the automatic backup, the drive shall allow two additional unique backup parameter sets to be stored. Backup files shall include a time and date stamp. In the event of a drive failure, the control panel of the original drive can be installed on the replacement drive, and parameters from that control panel can be downloaded into the replacement drive.

8. The control panel shall display local technical support contact information as part of drive fault status.

9. The control panel shall be removable, capable of remote mounting.

10. The control panel shall have the ability to store screen shots, which are downloadable via USB.

11. The control panel shall have the ability to display a QR code for quick access to drive information.

12. The LCD screen shall be backlit with the ability to adjust the screen brightness and contrast, with inverted contrast mode. A user-selectable timer shall dim the display and save power when not in use.

13. The control panel shall include assistants specifically designed to facilitate start-up. Assistants shall include: First Start Assistant, Basic Operation, Basic Control, and PID Assistant.

14. Primary settings for HVAC shall provide quick set-up of all parameters and customer interfaces to reduce programming time.

15. The drive shall be able to operate with the control panel removed.

D. All drives shall have the following hardware features/characteristics as standard:

1. Two (2) programmable analog 4-20mA inputs shall accept current or voltage signals. Current or Voltage selection configured via control panel. Drives that require access to internal components to perform these functions, are not acceptable.

2. Two (2) programmable analog 4-20mA outputs. At least one of the analog outputs shall be adjustable for current or voltage signal, configured via control panel. Drives that require access to internal components to perform these functions, are not acceptable.

3. Three (3) programmable Form-C relay outputs. The relay outputs shall include programmable on/off time delays. The relays shall be rated for a continuous current rating of 2 Amps. Maximum switching voltage of 250 VAC / 30 VDC. Open collector and Form-A relays are not acceptable. Drives that have less than (3) Form-C relay outputs shall provide an option card to provide additional relay outputs.

4. Drive terminal blocks shall be color coded for easy identification of function.

5. The drive shall include an isolated USB port for interface between the drive and a laptop. A non-isolated USB port is not acceptable.

6. An auxiliary power supply rated at 24 VDC, 250 mA shall be included.

7. The drive shall have cooling fans that are designed for field replacement. The primary cooling fan shall operate only when required and be variable speed for increased longevity and lower noise levels. Drives whose primary cooling fans are not variable speed, shall include a spare cooling fan.

8. The overload rating of the drive shall be 110% of its normal duty current rating for 1 minute every 10 minutes, 130% overload for 2 seconds every minute.

9. The input current rating of the drive shall not be greater than the output current rating. Per NFPA 70 430.122, drives with higher input current ratings may require the upstream wiring, protection devices, and source transformers to be upsized.

10. Circuit boards shall be coated per IEC 60721-3-3; Chemical gasses Class 3C2 and Solid particles Class 3S2.

11. Earth (ground) fault detection shall function in both modulating (running) and non-modulating modes.

12. Coordinated AC transient surge protection system consisting of 4 MOVs (phase-to-phase and phase-to-ground), a capacitor clamp, and internal chokes. The MOVs shall comply with UL 1449 4th Edition. Drives that do not include coordinated AC transient surge protection shall include an external TVSS/SPD (Transient Voltage Surge Suppressor/Surge Protection Device).

13. The drive shall include a robust DC bus to provide short term power-loss ride through. The DC bus Joule to drive kVA ratio shall be 4.5 J/kVA or higher. An inertia-based ride through function should help maintain the DC bus voltage during power loss events. Drives with control power ride through only, are not acceptable.

E. All drives shall have the following software features as standard:

1. A Fault Logger that stores the last 16 faults in non-volatile memory.

   a. The most recent 5 faults save at least 9 data points, including but not limited to: Time/date, frequency, DC bus voltage, motor current, DI status, temperature, and status words.

   b. The date and time of each fault and fault reset attempt shall be stored in the Fault Logger.

2. An Event Logger that stores the last 16 warnings or events that occurred, in non-volatile memory.

    a. Events shall include, but not limited to: Warning messages, checksum mismatch, run permissive open, start interlock open, and automatic reset of a fault.

    b. The date and time of each event's start and completion points shall be stored in the Event Logger.

3. Programmable start method. Start method shall be selectable based on the application: Flying-start, Normal-start, and Brake-on-start.

4. Programmable loss-of-load (broken belt / coupling) indication. Indication shall be selectable as a control panel warning, relay output, or over network communications. This function to include a programmable time delay to eliminate false loss-of-load indications.

5. Motor heating function to prevent condensation build up in the motor. Motor heating adjustment, via parameter, shall be in "Watts." Heating functions based only on "percent current" are not acceptable.

6. Advanced power metering abilities shall be included in the drive. Drives without these data points, must include a separate power meter with each drive.

    a. Instantaneous output power (kW)

    b. Total power, broken down by kWh.

    c. Time based kWh metering for: current hour, previous hour, current day, and previous day.

    d. Energy saving calculation shall be included that shows the energy and dollars saved by the drive.

7. The drive shall include a motor flux optimization circuit that will automatically reduce applied motor voltage to the motor to optimize energy consumption and reduce audible motor noise.

8. Run permissive circuit - There shall be a run permissive circuit for damper or valve control. Regardless of the source of a run command, the Drives shall provide a dry contact closure that will signal the damper to open. When the damper is fully open, an end-switch shall close, allowing the drive to run the motor.

    a. The drive shall also include a programmable start delay, for when an end-switch is not provided.

9. Start interlock circuit - Four separate start interlock (safety) inputs shall be provided. When any safety is opened, the motor shall be commanded to stop. The control panel will display the specific safety(s) that are open. The status of each safety shall be transmitted over the network communications. Wiring multiple safeties in series is not acceptable.

10. External fault circuit – Three separate external fault inputs shall be provided. This circuit shall have the same features and functionality as the start interlock circuit, except it shall require a manual reset before the drive is allowed to operate the motor.

11. The drive shall include a switching frequency control circuit that reduces the switching frequency based on actual drive temperature, and allows higher switching frequency settings without derating the drive. It shall be possible to set a minimum and a target switching frequency.

12. The drives nameplate horsepower shall be fully rated at 8kHz switching frequency with a minimum motor lead length of 150 feet.

13. Visual function block adaptive programming allowing custom control schemes, minimizing the need for external controllers. I.e. cooling tower staging logic. A free software tool shall be used to configure adaptive programming.

14. The ability to automatically restart after an over-current, over-voltage, under-voltage, external fault, or loss of input signal protective trip. The number of restart attempts, trial time, and time between attempts shall be programmable. Each of these faults may have automatic restart individually disabled via a parameter selection.

15. Three (3) programmable critical frequency lockout ranges to prevent the drive from operating the load continuously at an unstable speed/load.

16. Seven (7) programmable preset frequencies/speeds.

17. Two independently adjustable accel and decel ramps with 1 – 1800 seconds adjustable time ramps.

18. PID functionality shall be included in the drive.

    a. Programmable “Sleep” and “Wake up” functions to allow the drive to be started and stopped based on the level of a process feedback signal.

    b. The drive shall include an independent PID loop for customer use, assigned to an Analog Output. This PID loop may be used for cooling tower bypass valve control, chilled water valve, etc.

19. At least 4 parameter user sets that can be saved to the permanent memory and recalled using a digital input, timed function, or supervision function.

20. Drive shall be compatible with an accessory that allows the control board to be powered from an external 24 VDC/VAC source, allowing the drive control to remain powered by a UPS during an extended power outage.

21. A computer-based software tool shall be available to allow a laptop to program the drive. The drive shall be able to support programming without the need for line voltage. All necessary power shall be sourced via the laptop USB port.

22. The drive shall include a fireman's override mode. Upon receipt of a contact closure from the Fire Alarm Life Safety system, the drive shall operate in a dedicated Override mode distinct and separate from the drive's Normal operation mode. The following features will be available in the drive override function:

    a. The Override mode shall be secured by password to prevent changes once programmed.

    b. The drive shall ignore external inputs and commands not defined as part of the override function.

    c. Override operation mode shall be selectable between: single frequency, multiple fixed frequencies, follow an analog input signal, PID control, or come to a forced stop.

    d. High priority safeties shall stop the drive and lower priority safeties shall be ignored in Override mode.

    e. The drive shall be configurable to receive from 1 to 3 discrete digital input signals and operate at up to three discrete speeds.

23. The drive shall have multi-pump functionality and an intelligent master/follower configuration for controlling up to 8 parallel pumps equipped with drives. The drive shall have a parameter synchronization feature to program the PID, multi-pump, and AI parameters in all parallel drives. The functionality to start and stop the pumps based on capacity, operating time or efficiency of the pump to ensure each pump is operated regularly.

    a. The multi-pump functionality shall control:

        1) Flow Control

        2) Pressure Control

        3) Pump Alternation

F. Security Features

1. The drive manufacture shall clearly define cybersecurity capabilities for their products.

2. The drive shall include password protection against parameter changes.

   a. There shall be multiple levels of password protection including: End User, Service, Advanced, and Override.

   b. The drive shall support a customer generated unique password between 0 and 99,999,999.

   c. The drive shall log an event whenever the drive password has been entered.

   d. The drive shall provide a security selection that prevents any "back door" entry. This selection even prevents the drive manufacturer from being able to bypass the security of that drive.

   e. A security level shall be available that prevents the drive from being flashed with new firmware.

3. The "Hand" and "Off" control panel buttons shall have the option to be individually disabled (via parameter) for drives mounted in public areas.

G. Network Communications

1. The drive shall have an EIA-485 port with removable terminal blocks. The onboard protocols shall be BACnet MS/TP, Modbus, and Johnson Controls N2.

2. The drive shall have the ability to communicate via two protocols at the same time, one onboard protocol and one option card-based protocol. Once installed, the drive shall automatically recognize any optional communication cards without the need for additional programming.

3. The drive shall not require a power cycle after communication parameters have been updated.

4. The drive's relay output status, digital input status, analog input/output values, Hand-Auto status, warning and fault information shall be capable of being monitored over the network. The drive's start/stop command, speed reference command, relay outputs and analog outputs shall be capable of being controlled over the network. Remote drive fault reset shall be possible.

H. Disconnect – A circuit breaker shall be provided on all drives. The disconnect shall be door interlocked and padlockable. Drive short circuit protection shall be included on all packaged units that include a disconnecting means. All disconnect configurations shall be UL Listed by the drive manufacturer as a complete assembly and carry a UL508 label. Disconnect packages manufactured by anyone other than the drive manufacturer, are not acceptable.

I. Bypass – All drive/bypass configurations shall be UL Listed by the drive manufacturer as a complete assembly and carry a UL508 label. Bypasses manufactured by anyone other than the drive manufacturer, are not acceptable.

1. The drive and bypass package shall be a complete factory wired and tested bypass system consisting of a padlockable disconnect device, drive output contactor, bypass contactor, and drive input fuses.

2. The drive and bypass package shall have a UL listed short circuit current rating of 100 kA, for 240 VAC and 480 VAC systems, and this rating shall be indicated on the rating label.

3. The bypass control shall be powered by a three-phase switch mode power supply with a voltage tolerance of +30%, -35%. Single-phase power supplies and control power transformers (CPT) are not acceptable.

4. All bypass packages shall utilize a dedicated LCD bypass control panel (keypad) user interface. The bypass control panel must be a separate display from the drive control panel. Bypass packages that use a single shared drive/bypass control panel are not acceptable, due to that control panel acting as a single point of failure.

   a. The bypass shall include a two-line, 20-character LCD display. The display shall allow the user to access parameters and view:

      1) Bypass input voltage, current (Amps) and power (kW)

      2) Bypass faults, warnings, and fault logs

      3) Bypass operating time and energy consumption (resettable)

   b. The bypass control panel shall include the following controls:

      1) Four navigation keys (Up, Down, Enter, Escape)

      2) Bypass Hand-Off-Auto, Drive mode / Bypass mode selectors, Bypass fault reset

   c. The following LED indicating lights or control panel display indications shall be provided.

      1) Drive mode selected, Bypass mode selected

      2) Drive running, Bypass running

      3) Drive fault, Bypass fault

   d. Safety interlock and run permissive status shall be displayed using predetermined application specific nomenclature, such as: Damper end switch, smoke alarm, vibration trip, and overpressure.

5. All bypasses shall have the following hardware features/characteristics as standard:

   a. Six (6) digital inputs and five (5) Form-C relay outputs. The digital inputs shall be capable of accepting both 24 VDC and 24 VAC. The bypass control board shall include an auxiliary power supply rated 24 VDC, 250 mA.

   b. Drive isolation fuses shall be provided. Bypass designs which have no such fuses, or that only incorporate fuses common to both the drive and the bypass are not acceptable. Third contactor "isolation contactors" and service switches are not an acceptable alternative to drive isolation fuses.

   c. The bypass shall be able to detect a single-phase input power condition while running in bypass, disengage the motor, and provide a single-phase input power indication.

   d. The bypass shall be designed for stand-alone operation and be completely functional in both Hand and Automatic modes, even if the drive and/or drive's control board has failed. Network communications shall remain functional. Bypass systems that do not maintain full functionality in the event of a drive failure, are not acceptable.

6. All bypasses shall have the following software features as standard:

   a. Programmable loss-of-load (broken belt / coupling) indication shall be functional in drive and bypass mode.

   b. The bypass shall also support run permissive and start interlock control functionality, including start delay, as previously specified in the drive section.

   c. The bypass control shall monitor the status of the drive and bypass contactors and indicate when there is a welded contactor contact or open contactor coil.

   d. The bypass shall include a selection for either manual or automatic transfer to bypass. The automatic transfer mode shall allow the user to select the specific drive fault types that result in an automatic transfer to bypass. The automatic transfer mode shall not allow a transfer to bypass on motor related faults. Automatic transfer schemes that do not differentiate between fault types, are not acceptable.

   e. The bypass shall include the ability to select the operating mode of the system (Drive/Bypass) from either the bypass control panel or digital input.

f. The bypass shall include a supervisory control mode that monitors the value of the drive's analog input (feedback). This feedback value is used to control the bypass contactor on/off state. The supervisory mode shall allow the user to maintain hysteresis control over applications such as cooling towers and booster pumps.

g. Selectable Class 10, 20, or 30 electronic motor overload protection shall be included in both drive and bypass mode.

h. The drive and bypass shall be designed to operate as an integrated system when in Override mode. Whether operating in drive or bypass mode, the low priority safeties will be ignored, and high priority safeties will be followed. External start/stop commands will be ignored. There shall be four selectable Override modes:

1) Bypass only, with two smoke control modes:

a) Fixed pre-configuration of digital inputs

b) Configurable high/low priority safeties and faults, to allow configuration to meet needs of local Authority Having Jurisdiction.

2) Drive only

3) Drive then transfer to bypass, in the event of a drive fault

4) Force to Stop

7. The bypass relay output status, digital input status, warning and fault information can be monitored over the network. Status information shall be monitored, including; operating mode (drive vs bypass), current drawn in bypass mode, broken belt, and phase-to-phase voltage. The bypass start/stop command, force to bypass command, and relay outputs shall be capable of being controlled over the network.

2.2 STANDARD ADJUSTABLE SPEED DRIVE

A. Technology and Harmonics Performance:

1. The standard ASD shall produce an adjustable AC voltage / frequency output. It shall be of the pulse-Width Modulated (PWM) technology and shall consist of a 6-pulse minimum full-wave diode bridge converter to convert incoming AC utility power to DC power, a capacitor filter/storage network and an inverter power transistor switching output section. The microprocessor controller generating inverter output shall include the internal base driver and specified protection and sensing circuits. The ASD waveform generator shall be IGBT based and capable of extended carrier frequency operation.

2. Provide all standard adjustable speed drives less than 25 horsepower with dual (positive and negative DC link) chokes equivalent to 5% to reduce the harmonics to the power line.

3. Harmonic Performance: THD <45% above 60% load

B. Design Make: ABB ACH580 Series

C. Acceptable Equivalents:

1. Danfoss VLT HVAC Series

2. Eaton PowerXL DH1 HVAC Series

3. Yaskawa HV600 Series

3.0 PART 3 - EXECUTION

3.1 INSTALLATION

A. Install incoming 60Hz power conductors and frequency modulated conductors in separate conduits.

B. Electrical contractor to provide fire alarm fan shut down relay connection between I/O's "12" and "18". Provide normally closed connection such that the connected air handler supply or return fan motor stops when the fan shut down relay is actuated. This relay shall be installed in series with the DDC system start/stop signal.

C. Install ASD in an accessible location. Refer to contract documents for more information.

D. Motor lead lengths shall not exceed manufacturers recommendations as described in part 2 of this section.

E. Provide all start up services and training as described in part 1 of this section.

F. Completely assemble and provide connections to all terminal or terminal strips and any miscellaneous control devices.

G. Input and motor leads for each ASD shall be in a separate dedicated steel conduit.

H. Adjust drive controls in accordance with manufacturer's requirements. Switching frequency shall have an initial set point of 6 KHz.

I. Coordinate entire installation, including communications interface with the temperature control contractor prior to ordering ASD.

J. Provide factory trained representative and drive programming as required to meet temperature controls sequence of operation.

K. Coordinate controls programming with the Division 22 or 23 contractor.

L. When the ASD is located remotely from the motor and the associated disconnect switch, provide an interlock in the disconnect switch and provide 2-#12AWG in ½" C from the ASD to the interlock. This shall be interfaced to disable the ASD prior to disconnection of power to the motor.

3.2 COORDINATION

A. Provide motor overload programming for connected load. Coordinate sizes with Division 22 or 23 contractor.

B. Provide all terminations of control wiring and coordinate with Division 22 or 23 contractor.

C. Prior to releasing the adjustable speed drive order the Division 26 contractor shall obtain verification in writing from the Division 22 and 23 contractors that all sizes and types are correct. The Division 26 contractor shall bear all cost if written approval is not obtained prior to releasing the order and size changes are required.

3.3 WARRANTY

A. The drive product warranty shall be 24 months from the date of installation and programming. The warranty shall include parts, on-site labor, and travel time and travel costs, or replacement of the complete drive as determined by the drive manufacturer's technical support representative.

END OF SECTION 262923

SECTION 265100 - LIGHTING

1.0 PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide complete installation, including luminaires, standards, hangers, supports, fittings, lamps, wiring, and connections as indicated in the Contract Documents. Types of luminaires in this project include LED.

B. Refer to the General and Supplementary Conditions, Division 1 Specifications Sections for proposed phasing of this project.

C. Refer to Specification Section 019113 for commissioning requirements related to this project.

D. Refer to section 260923 for Wired Lighting Controls.

1.2 SCOPE OF WORK

A. This section includes minimum requirements for the following:

1. LED Luminaires
2. LED Drivers
3. Lamps
4. Emergency Driver
5. Diffusers
6. Light Poles and Standards

1.3 SUBMITTALS

A. Submit shop drawings as described in Section 260010. All luminaire types and components shall be submitted in a single complete brochure which shall be in the form of a soft cover binder with each luminaire separated by an identified index tab. Information on each luminaire shall include:

1. Manufacturer and Catalog Number.
2. Dimensioned Construction Drawing(s).
3. Standard Catalog "Cut" Sheet.
4. Lumen Output
5. CRI and Kelvin Temperature

6. Lens/Louver Type.

7. Driver w/ Dimming Technology

8. Lamp Type.

9. Lumen Loss Information

B. Emergency Driver

C. Light Poles and Standards

D. Warranty Information

1.4 QUALITY ASSURANCE

A. Luminaires shall be standard products of manufacturers regularly engaged in the manufacture of the specific type luminaires specified and shall be the manufacturer's latest standard design that complies with specification requirements. Firms installing the luminaires shall have a minimum of five (5) years of successful installation experience on projects with interior lighting work similar to the requirements of this project.

B. Codes and Standards

1. NEC:

a. Shall comply with Articles 220, 410, 510 and 700 as applicable to installation and construction.

2. NEMA:

a. Shall comply with Standard Publication Nos. LE 1 and LE 2 as applicable to lighting equipment.

3. UL:

a. All interior lighting luminaires and components shall be UL listed and labeled.

b. Comply with all applicable UL standards including UL 486A and B.

4. CBM:

a. Fluorescent and HID ballasts shall comply with Certified Ballast Manufacturers Association standards and carry the CBM label.

5. All work shall comply with applicable local code requirements of the authority having jurisdiction.

C. Verify the availability of all luminaires proposed to be used in the execution of the work prior to submitting for approval. The discontinuance of production of any luminaire after such approval has been granted shall not relieve the Contractor from furnishing an approved luminaire of comparable quality and design at no additional cost.

D. Luminaires shall be as specified in the "Luminaire Schedule." Luminaire types, characteristics, photometrics, finishes, etc., correspond to the first manufacturer, and associated catalog number, listed in the "Luminaire Schedule." Provide a sample luminaire from the factory for any products not listed as acceptable for approval. The Owner's Representative reserves the right to disapprove any luminaire type submitted which is not equal in quality, appearance or performance to the luminaire specified.

E. All luminaires shall meet the Total Luminaire Efficiency (TLE) requirements of the New York State Energy Conservation Construction Code.

2.0 PART 2 - PRODUCTS

2.1 LED LUMINAIRES

A. General:

1. Manufacturers shall be a registered with the Department of Energy (DOE) as a Quality Advocate and taken the pledge to be listed on the LED lighting facts website.

2. Luminaire measurements have been standardized and are in compliance with IESNA Standard LM-79 test procedure.

3. LED’s have been standardized and are in compliance with IESNA Standard LM-80 and demonstrate L70 life after 50,000 hours.

4. Luminaires shall be either Energy Star certified, or Design Lights Consortium (DLC) listed to qualify for NYSERDA or Utility provider rebate incentives. Submitted luminaires not currently on the DLC or Energy Star listed products list (http://www.designlights.org/) will be rejected.

5. Manufacturers shall prove color consistency across all LED’s via 3 step MacAdam Ellipse.

6. Luminaires shall be tested at an ambient temperature of +25 degrees for a minimum of 6000hrs.

7. Maximum junction temperature of 80°C.

8. Minimum drive current of 350mA. Maximum drive current of 700mA.

9. All LED luminaires shall have a minimum Color Rendering Index (CRI) of 80.

10. Luminaires shall a minimum 5-year warranty.

11. Refer to Luminaire Schedule on drawings for complete Luminaire makes and models.

2.2 LED DRIVERS

A. Dimmable Driver (0-10v):

1. Drivers shall be of the constant current type.

a. Voltage: 120/277 as noted on drawing

b. Driver Current: 350mA – 700mA.

c. 0-10v dimming capable down to 1%.

d. Maximum THD: 10%

e. Minimum Power Factor: 0.9

2. Acceptable Manufacturers.

a. eldoLED - ECOdrive

b. Signify Advance – Xitanium

c. Osram Sylvania – Optotronic

d. Lutron Hi-lume

2.3 EMERGENCY DRIVER

A. Emergency Ballast shall be installed in conjunction with LED Driver intended for normal luminaire operation. Contains internal battery that shall automatically switch over to power designated lamp(s) upon loss of normal power via internal voltage sensing device. Battery shall be maintenance free, nickel-cadmium type, and be an integral part of ballast assembly. Life expectancy of battery shall be minimum of seven years.

B. All emergency ballasts shall be inverter type with Class 2 Output.

C. UL listed metal enclosure.

D. UL 924 listed for Emergency Lighting and Power Equipment

E. Temperature Operation: 20°C to +55°C

F. Shall include an emergency test switch with LED indicator remotely mounted in outlet box in ceiling above or adjacent to luminaire.

G. Recessed LED Downlight Luminaire LED performance – Shall up to 300 lumens minimum of 90 minutes on an output voltage of 30-130VDC. Design Makes: LED – Bodine BSL17 Series

H. Linear style LED Strip LED performance – Shall up to 1,000 lumens minimum of 90 minutes on an output voltage of 15 - 52 VDC. Design Makes: LED – Bodine BSL310 Series

I. Acceptable Manufacturers.

a. Bodine BSL Series

b. IOTA Engineering

c. Dual-lite

2.4 DIFFUSERS

A. Lenses:

1. Extruded 100 percent virgin acrylic material with a minimum weight of ten ounces per square foot.

2. Type 12 - Clear material with 0.125 inch overall thickness with .080 Inch penetration comprised of 3/16 inch square based female cones aligned 45 degrees to the length and width of the panel.

3. Type 19 - Clear material with 0.156 inch overall thickness with 0.080 inch penetration comprised of 3/16 inch square based male cones aligned parallel and perpendicular to the length and width of the panel.

4. White matte - White material with 0.125 inch overall thickness.

5. While overlay - White material with 0.040 inch overall thickness.

6. The maximum deflection at the center of a 2 foot x 4 foot lens shall be no greater than 0.250 inch. Arched or warped lenses will not be accepted.

7. Parabolic Louvers

a. Medium cell louver - One piece injection molded acrylic, with all parabolic surfaces prepared with a primary undercoat, highly specular vacuum metalized finish, and encapsulated in a protective acrylic lacquer coating. Cell dimensions shall be nominal 1-1 /2 inches x 1-1 /2 inches x I inch deep, and shall provide approximately 38 degree shielding with a louver efficiency of not less than 52 percent. This louver shall have a VCP index rating of 0.93 for semi-specular silver finish. Panel finish shall be specular silver.

8. Baffles and Louvers

a. Cross Baffle - Constructed of 0.050 inch aluminum with one-way blades to provide 45 degree shielding. Blades 1-1/2 inches high and spaced 1-1/2 inches apart. While enamel finish. Side shields for support of the blades. Width to extend the full width of the lighting unit and of lengths to form a continuous baffle with no visible joints. Where inside and outside comers are required, the blades shall be mitered.

b. Parabolic Baffle - Constructed of 0.050 inch aluminum with one-way blades to provide 45 degree shielding. Blades 1-1/2 inches high and spaced 1-1/2 Inches apart. Clear anodized finish. Side shields for support of the blades. Width to extend the full width of the lighting unit and lengths to form a continuous baffle with no visible joints. Where inside and outside comers are required, the blades shall be mitered.

c. Directional Louver - Constructed and fabricated of aluminum with a "cold bonding joint method for integral vibration free and precise alignment of cells. Louver finish shall be custom color as directed by the Architect.

2.5 LIGHT POLES AND STANDARDS

A. Metal Pole Lighting Standards: Provide metal, raceway-type, lighting poles and standards, of sizes and types indicated, comprised of shafts and tenon joints. Equip with grounding connections readily accessible from handhole base access doors; and construct of the following materials and additional construction features:

1. Material: Aluminum

2. Configuration: Anchor base type with hand hole and cover.

3. Metal Lighting Standard Accessories: Provide accessories for metal lighting standards, including anchor bolts, as recommended by lighting standard manufacturer, of sizes and materials needed to meet erection and loading application requirements.

4. Provide metal seamless square anchor bolt cover to match pole construction.

5. Provide pole with adequately sized reinforced handhole complete with matching cover 18" above grade level. Weld 1/2' grounding nut on shaft with accessibility from handhole. Design poles to withstand loads developed by 100 MPH wind pressure, as adjusted for height above ground level, structural shapes and cable wire loading.

B. Integrated Controls: Provide Qty. (2) wireless remote controls to make control adjustments for all required photocell sensor setpoints, occupancy sensor sensitivity, and associated delays.

C. All exterior light poles shall include integral surge-arrestors to protect the luminaire and driver. Surge Arrestor Design Make: Ditek DTK-DL Series.

2.6 LUMINAIRE SCHEDULE

A. Luminaire schedule is found on the drawings.

3.0 PART 3 - EXECUTION

3.1 EXAMINATION:

A. Examine areas and conditions under which luminaires are to be installed, and substrate for supporting luminaires. Notify Architect in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 COORDINATION

A. Refer to respective reflected ceiling plan for each area. Reflected ceiling plans indicate proper luminaire location only. Locate occupancy sensors and photo sensors per the manufacturer’s recommendations. Coordinate the proper arrangement with all other ceiling mounted items. Contract Documents indicate luminaire characteristics (type), quality, quantity, etc. Verify with the ceiling supplier design of actual ceiling installed in each area and coordinate compatible luminaire flange/trim type.

B. General

1. Install interior luminaires at locations and heights as indicated, in accordance with luminaire manufacturer's written instructions, applicable requirements of NEC, NECA's 'Standard of Installation", NEMA standards, and with recognized industry practices.

2. Provide luminaires and/or luminaire outlet boxes with hangers to properly support luminaire weight. Submit design of hangers, method of fastening, other than indicated or specified herein, for review by Engineer.

3. Make installation such that the luminaire is free of finger marks, flaws, scratches, dents or other imperfections.

4. Arrangement

a. Align edges of luminaires with walls or other building elements. Where indicated by dimensions or indicated on Drawings, maintain indicated arrangement.

b. For wall to wall installed luminaires, field measure length required after completion of the wall construction and prior to ordering the luminaires. Fabricate in largest lengths allowable.

5. Recessed Mounting

   a. Verify ceiling construction and material prior to ordering luminaires. Provide plaster frames for plaster ceilings and flanged frames for drywall ceiling. Provide necessary mounting hardware and accessories to adapt luminaire to ceiling construction. Provide gaskets, trims, flanges, etc. as required to prevent light leaks around trim. Where installing 'lay-in' type luminaires, each Luminaire shall be supported completely independent of the ceiling system by way of 12-AWG galvanized steel support wires. Support wires shall be attached from all four corners of the Luminaire housing to the building structure. Each support shall be capable of supporting 100 pounds. Provide saddle hangers or tie bars attached to runners or between crossbars of ceiling systems as a safety measure. Provide mounting splines or other positive means of maintaining alignment and rigidity.

6. Stem Mounting

   a. Use self-aligning hangers in canopies for hanging luminaires true to vertical. Do not deface ceiling or walls. Locate hangers at intersections of joints or at centers of blocks in rooms with patterned type ceiling materials such as acoustic tile. Use hangers capable of supporting four times luminaire weight. Align continuous rows of luminaires maintaining luminaires level without rotation about the longitudinal axis. Rigidly support outlet box independent of ceiling system from building structure. Where obstructions prevent direct support of outlet, provide offset or trapeze hangers of outlet box. Stem shall be supported directly from building structure on centers as called for by the manufacturer. There shall be a minimum of two stems per individual four-foot luminaire, and three stems per individual eight foot luminaire for steel luminaires. Extruded aluminum luminaires shall have hangers as called for by the manufacturer.

   b. Provide brackets from the manufacturer of the same finish and material as the luminaires to present a seamless continuous row mounting appearance. Provide continuous row mounting brackets between all adjoining luminaires.

7. Surface Ceiling Mounting

   a. Mount surface luminaires tight to surface without distorting surface. Space luminaires in continuous rows to correspond to ceiling joint intersections. Continuous row luminaires may be fed by a single outlet where luminaires contain approved wireways and suitable wiring is used. Provide hangers for each luminaire, each rated to support four times the luminaire weight. Provide offset or trapeze hangers where required. Supports shall be provided on a maximum of 4-foot centers with a minimum of two hangers per individual four foot luminaire and three hangers per individual eight foot luminaire. Hangers shall be supported from the building structure and independently from ceiling system or other building services.

b. Fasten luminaires securely to structural supports.

3.3 DELIVERY, STORAGE, AND HANDLING

A. Luminaires and equipment shall be delivered with UL and manufacturer's labels intact and legible in factory fabricated containers.

B. Luminaires and accessories shall be stored in protected dry locations in their original unbroken package or container. Luminaires shall be protected from dust and dampness both before and after installation. Luminaires shall be protected from paint and cleaning solvents during all phases of construction.

C. Handle interior lighting luminaires carefully to prevent damage, breaking, and scoring of finishes. Do not install damaged luminaires or components; replace them with new.

3.4 SEQUENCING AND SCHEDULING

A. Coordinate with other work including ceiling type, wires/cables, electrical boxes, fittings, and raceways, to properly interface installation of interior luminaires with other trades.

3.5 REUSE AND REPAIR OF EXISTING LUMINAIRES

A. Reuse existing luminaires only where called for. Perform the following work, as required, to upgrade existing luminaire. Replace faulty, leaking, or noisy ballast. Replace broken, damaged, worn, or faulted lamp sockets. Provide new luminaire wire. Provide new acrylic lens system to match existing, where existing is broken. Re-lamp luminaires. Completely damp clean lens and interior of luminaires.

B. If ballasts have leaked, remove material deposited in luminaire. Assume material was PCB contamination, or a test samples to show material is not PCB and submit a report. Dispose of material as required by EPA, including clean-up materials used. Dispose of ballast which does not have non PCB label in PCB containers and have containers taken to EPA approved incinerators. Follow all EPA regulations for transporting material.

C. New luminaires may be provided to replace existing luminaires scheduled to remain or be reused, subject to shop drawing approval.

3.6 REMOVAL OF BALLAST IN EXISTING LUMINAIRES

A. Assume ballast contains PCB materials unless labeled otherwise or test samples to show materials are not PCB; submit test report. Remove all ballast from existing luminaires indicated on contract documents. Dispose of all ballast which do not have non-PCB labels in PCB containers and pay all costs to have containers taken to EPA approved incinerators and disposed of per all EPA regulations. Follow all EPA regulations for transporting containers and materials. If ballast has leaked in the existing luminaire, remove material deposited in luminaire and dispose of those materials as listed above. Provide Certificate of Disposal and all associated paperwork to Owner’s representative.

3.7 REMOVAL OF LAMPS IN EXISTING LUMINAIRES

A. Assume all fluorescent lamps contain Mercury materials unless labeled otherwise or test samples to show materials do not contain Mercury and submit test report. Remove all lamps from existing luminaires indicated on contract documents. Dispose of all lamps which do not have non-Mercury labels in compliance with the requirements of the New York State Department of Environmental Conservation and all applicable Federal Laws. Follow all regulations for transporting materials. Provide Certificate of Disposal and all associated paperwork to Owner's representative.

3.8 LIGHT POLES AND STANDARDS

A. Paint all scratch marks on poles with factory supplied touch-up paint.

B. Locate the surge-arrestor in the light pole base for accessibility.

3.9 EMERGENCY DRIVERS

A. Provide separate non-switch conductor from line side of lighting circuit to each emergency driver voltage sensing input. Refer to manufacturers wiring diagram.

B. Connect all emergency drivers to allow switching unless luminaire is specifically shown to be used as a night light.

C. Provide adhesive 1" diameter round red sticker on all luminaires with internal emergency drivers.

D. Provide remote test switch or testing means for all emergency drivers accessible from below ceiling.

3.10 LAMPS

A. Provide lamps in all luminaires.

B. Replace any lamp whose color is determined to be unsatisfactory. Replace all lamps which are found to have failed during the 12 month warranty period.

C. All lamps shall be new and unused. If permanent lighting system is used for temporary construction lighting, lamps shall be replaced upon turn over to Owner.

D. Furnish stock or replacement lamps amounting to 15%, but not less than 4 lamps in each case, of each type and size lamp used in each type luminaire. Deliver replacement stock as directed to Owner's storage space.

3.11 WARRANTY

A. All lighting and lighting controls equipment included in this section shall be fully tested and guaranteed for a period of five years after Owner's Representative written acceptance.

3.12 FINAL CLEANING

A. Prior to acceptance, damp clean diffusers, glassware, trim, reflectors, lamps, louvers, lens and similar objects of all luminaires. Remove all dirt, corrosion, foreign material, finger marks, and blemishes. Replace all burned out lamps and failed components.

END OF SECTION 265100

SECTION 271000 - HORIZONTAL AND BACKBONE COMMUNICATION CABLING

1.0 PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents. This work includes sleeves, raceways, cable hangers, connectors, outlets, patch panels, termination, testing, and labeling.

1.2 SCOPE OF WORK

A. Horizontal cabling includes STP between access control system, and security system equipment and devices as required by the manufacturer and called for on the drawings.

B. Horizontal cabling includes Category 6 UTP and for IP cameras and Public Address Speakers and 6A UTP for all data outlets from the Communications Equipment Room (CER) to the outlets as called for on the drawings. The horizontal cabling includes all horizontal cables, patch panels, patch cables, termination, testing, and mechanically terminated jacks/inserts and faceplates in the work area and the mechanical termination in the CER.

C. Provide the below installed patch cable installations. Coordinate with owners IT representative for specific ports to connect. Turn all unused patch cables over to owners IT representative at end of project and obtain sign off sheet to include with O&Ms.

1. Provide (25) Cat. 6 1-foot Patch Cables

2. Provide (25) Cat. 6A 1-foot Patch Cables

D. Provide 15-foot service loop of horizontal cable at each WAP outlet location. Neatly coil and Velcro wrap the service loop in an accessible location.

E. Horizontal cabling includes audio and video cabling as indicated on the drawings.

F. This section includes minimum requirements for the following:

1. Cat. 6 Cabling

2. Cat. 6 Patch Cables

3. Cat. 6A Cabling

4. Cat. 6A Patch Cables

5. Connecting Hardware

6. 100 Ohm UTP Cable Testing

7. Audio/Video (A/V) Cabling and Accessories

8. STP Cabling

1.3 QUALITY ASSURANCE

A. All cable shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

B. Provide with the submittals, documentation from an independent testing agency indicating that the complete assembly including cable and termination hardware has been tested and meets the performance criteria called for.

C. Provide contractor or sub-contractor experienced in all telephone and fiber splicing and trained and experience with the fusion splicing equipment to be used on this project.

D. Materials and work specified herein shall comply with the applicable requirements of:

1. ANSI/TIA/EIA – 568-A

2. ANSI/TIA/EIA – 568-C

3. ANSI/TIA/EIA – 569-B

4. NFPA 70 - 2014

5. BICSI Telecommunications Distribution Methods Manual

6. FCC 47 CFR 68

7. NEMA - 250

8. NEC - Articles 770 and 800

1.4 SUBMITTALS

A. Manufacturers catalog sheets, specifications and installation instructions for all products in this section.

B. Fusion splicing kits, pigtails, and splice trays.

C. Test results for all telephone and data UTP cable, and fiber splicing, new fiber cable installations performed in this project. Submit immediately upon completion of cable installation for review and include second copy in final O&M manuals.

2.0 PART 2 - PRODUCTS

2.1 GENERAL

A. Provide an end-to-end connectivity solution in which all horizontal cabling and connecting hardware are made by the same manufacturer. At a minimum, all connecting hardware and UTP patch panels shall be from the same manufacturer. Refer to specification section 271100 for additional information regarding patch panels.

2.2 CAT. 6 CABLING (100 OHM UNSHIELDED TWISTED PAIR)

A. Shall be Category 6 type cable compliant with the requirements of the most current edition of the 568-B.2-1 standard.

B. Physical Characteristics:

1. Shall be CMP, plenum rated.

2. Conductor shall be 23 AWG solid bare annealed copper.

3. Outer jacket color shall be blue.

4. Category marking shall be printed every one foot. Footage indicators shall also be provided on jacket.

5. The diameter of the insulated conductor shall be .023 in. maximum.

6. Shall consist of (4) twisted pairs.

7. Shall be suitable for the environment in which they are to be installed.

8. The color coding of pairs shall be:

Pair 1	W-BL; BL
Pair 2	W-O; 0
Pair 3	W-G; G
Pair 4	W-BR; BR

9. The overall diameter of the cable shall be less than 0.240 inches.

10. The ultimate breaking strength measured in accordance with ASTM D 4565 shall be 400 N minimum.

11. Cable shall withstand a bend radius of 1 inch at -20 degrees Celsius without jacket or insulation cracking.

C. Transmission Characteristics:

1. Cable shall be tested & characterized to 500 MHz.

a. Cable shall exhibit a NEXT loss of at least the following:

Frequency MHz	NEXT dB
1.0	78
4.0	69
10.0	63
16.0	60
20.0	58
31.25	55
62.5	51
100.0	48
200	44
250	42

b. Cable shall exhibit an ELFEXT loss of at least the following:

Frequency MHz	ELFEXT dB
1.0	75
4.0	63
10.0	55
16.0	51
20.0	49
31.25	45
62.5	39
100.0	35
200	29
250	27

c. Cable shall exhibit an Attenuation loss of less than the following:

Frequency MHz	Attenuation dB
1.0	2.0
4.0	3.8
10.0	6.0
16.0	7.6
20.0	8.5
31.25	10.7
62.5	15.4
100.0	19.8
200	29.0
250	32.58

d. Cable shall exhibit a Return loss according to the following:

Frequency MHz	Return Loss (dB)
1	20.0
4	23.0
10	25.0
16	25.0
20	25.0
31.25	23.6
32.5	21.5
100	20.1
200	18.0
250	17.3

D. Design Make: Belden DataTwist 2400 Series

E. Acceptable Manufacturers:

1. OCC

2. Bertek

3. Commscope

2.3 CAT. 6 PATCH CABLES

A. Category 6 - TIA 568.C.2 compliant.

B. Ultra-small diameter patch cord.

C. Max. 28 AWG conductors.

D. Factory terminated RJ-45 male at both ends with strain relief boot at each end of cable. T568A/B-T568A/B.

E. 1-foot in length minimum.

F. Blue in color.

G. Design Make: Belden Small OD 28 AWG Patch Cords

H. Acceptable Manufacturers:

1. Legrand Quicktron Snagless Slim Patch Cable

2. Panduit UTP2SP1 Series

2.4 CAT. 6A CABLING (100 OHM UNSHIELDED TWISTED PAIR)

A. Shall be Category 6A type cable compliant with the requirements of the most current edition of the TIA/EIA-568-B.2-10-2008 standard.

B. Physical Characteristics:

1. Shall be CMP, plenum rated.

2. Conductor shall be 23 AWG solid bare annealed copper.

3. Outer jacket color shall be blue.

4. Category marking shall be printed every one foot. Footage indicators shall also be provided on jacket.

5. The diameter of the insulated conductor shall be .023 in. maximum.

6. Shall consist of (4) twisted pairs.

7. Shall be suitable for the environment in which they are to be installed.

8. The color coding of pairs shall be:

Pair 1	W-BL; BL
Pair 2	W-O; 0
Pair 3	W-G; G
Pair 4	W-BR; BR

9. The overall diameter of the cable shall be no greater than 0.295 inches.

10. The ultimate breaking strength measured in accordance with ASTM D 4565 shall be 400 N minimum.

11. Cable shall withstand a bend radius of 1 inch at -20 degrees Celsius without jacket or insulation cracking.

C. Transmission Characteristics:

1. Cable shall be tested & characterized to 625 MHz.

a. Cable shall exhibit a PSNEXT loss of at least the following:

Frequency MHz	NEXT dB
1.0	73.3
4.0	64.3
10.0	58.3
16.0	55.2
20.0	53.8
31.25	50.9
62.5	46.4
100.0	43.3
200	38.8
250	37.3
300	36.1
400	34.3

500	32.8
625	31.4

b. Cable shall exhibit an Attenuation loss of less than the following:

Frequency MHz	Attenuation dB
1.0	2.1
4.0	3.8
10.0	5.9
16.0	7.5
20.0	8.4
31.25	10.5
62.5	15.0
100.0	19.1
200	27.6
250	31.1
300	34.3
400	40.1
500	45.3
625	51.2

c. Cable shall exhibit a Return loss according to the following:

Frequency MHz	Return Loss (dB)
1	20.0
4	23.0
10	25.0
16	25.0
20	25.0
31.25	23.6
62.5	21.5
100	20.1
200	18.0
250	17.3
300	16.8
400	15.9
500	15.2
625	14.5

D. Design Make: Belden 10GX13 Series

E. Acceptable Manufacturers:

1. OCC
2. Bertek
3. Commscope

2.5 CAT. 6A PATCH CABLES

A. Meets all above requirements for 100 OHM unshielded twisted pair cable (Cat. 6A cable), except stranded conductors.

B. Factory terminated RJ-45 male at both ends with strain relief at ends of the cable.

C. Ultra-small diameter patch cord.

D. 1-foot in length.

E. Outer jacket color shall be as noted in this section above.

F. Design Make: Belden CAD110XXX Series

G. Acceptable Manufacturers:

1. OCC

2. Bertek

3. Commscope

2.6 COPPER CONNECTING HARDWARE

A. Color shall be electric white or ivory unless otherwise noted below.

B. Physical Characteristics

1. Faceplates shall be provided with labels and plastic label protector strip.

2. Faceplates shall be modular keystone jack type, 4-port minimum or 1-gang opening with mounting bezels to accept combination keystone jacks and multimedia jacks.

3. Each jack shall be an individually constructed unit and shall snap mount into the faceplate keystone opening.

4. Jack housings shall be high impact 94 V-0 rated thermoplastic.

5. Jacks shall have a temperature rating of -10 °C (14°F) to 60°C (140 °F) in conformance with ANSI/TIA/EIA-568-A.

6. Jack housings shall fully encase and protect printed circuit boards and IDC fields.

7. Housing shall be ultrasonically welded for tamper resistance.

8. Modular jack contacts shall accept a minimum of 2500 mating cycles without degradation of electrical or mechanical performance.

9. UTP jack IDCs shall accept a minimum of 20 re-terminations without degradation of electrical or mechanical performance.

10. Contacts will maintain a minimum vertical deflection force of 100 grams over deflection window.

11. Modular jack contact wires shall be formed flat for increased surface contact with mated plugs.

12. Modular jack contacts shall be constructed of Beryllium copper for maximum spring force and resilience.

13. Jack termination shall follow the industry standard 110 IDC. Includes insulated barrier between IDC contacts.

14. Jacks shall have a designation indicating the cable type on the nose which can be plainly seen from the front of the faceplate.

15. Jacks shall utilize a paired punch down sequence. Cable pair twists shall be maintained up to the IDC, terminating all conductors adjacent to its pair mate to better maintain pair characteristics designed by the cable manufacturer.

16. Jacks shall terminate 22-26 AWG stranded or solid conductors.

17. Jacks shall include wire retention stuffer cap that hold terminated wires in place and allow the conductors to be visually inspected in the IDC housing.

18. Jacks shall be color code marked with both T-568A and T-568B wiring.

C. RJ-45 Jack Design Makes:

1. Cat. 6A Data Jacks +18” AFF (Orange Colored)

2. Cat. 6 Data Jacks +18” AFF (Orange Colored)

3. Voice Jacks at +18” AFF (Blue Colored)

4. Voice Jacks +48” AFF in Plastic Wall Mount Phone Bracket w/ Metal Ears – Belden AX102902 w/ Blue Cat. 6 Jack

5. Design Make: Belden AX10XXXX Series

D. Multimedia & Accessory Jack Design Makes:

1. Blank Jack Snap-In –Belden AX102262

2. HDMI coupler – Belden AX105345-XX

3. USB 3.0 Coupler, A to A – Belden AX105342-XX

4. Other components and mounting bezels/inserts as required for special mounting conditions and for floor boxes, surface raceways and modular furniture.

E. Faceplate Design Makes:

1. Single Gang 4-Port Faceplate w/ ID Windows – Belden AX102249

2. Single Gang Faceplate for Combination Multimedia & Data Jacks – Belden AX101747. Provide w/ required bezels/inserts

F. Acceptable Manufacturers:

1. Panduit

2. Hubbell

3. Legrand

2.7 100 OHM UTP TESTER

A. User Interface

1. 240 x 320 backlit LCD display

2. Date stamp of all tests

3. Tone generation audio warning

B. Physical interface shall be modular RJ-45 connector and a serial port with DB-9 connector.

C. Shall test cable for compliance with the following standards:

1. TIA Category 3, 5E, 6 and 6A: 100 Ohm

2. ISO/IEC 11801 and EN 50173 Class C and D: Link

3. ISO/IEC 11801 and EN 50173 Class C and D (new): Permanent Link or Channel

4. Aus/NZ Class C and D: Basic Link or Channel

5. STP cabling, (IBM Type 1, 150 □)

6. ANSI TP-PMD IEEE 802.3 10BASE5, 10BASE2: Ethernet with coaxial cabling

7. IEEE 802.3 10BASE-T, 100BASE-TX, 1000BASE-T: Ethernet with twisted pair cabling IEEE 802.5: Token Ring, 4 Mbps or 16 Mbps

D. Shall perform the following tests as a minimum:

1. NEXT, NEXT @ Remote

2. Wire Map

3. Characteristic Impedance

4. Length

5. DC Loop Resistance

6. Propagation Delay Return Loss (RL), RL @ Remote

7. Delay Skew

8. Attenuation

9. Attenuation-to-Crosstalk Ratio (ACR), ACR @ Remote

10. Power Sum ACR, PSACR @ Remote

11. ELFEXT, ELFEXT @ Remote

12. Power Sum ELFEXT, PSELFEXT @ Remote

13. Power Sum NEXT, PSNEXT @ Remote

E. Shall use injector for complete wire mapping and TDR for determining cable length.

F. Shall measure NEXT for all six pair combinations and Attenuation on all four pairs from 1.0 to 500 MHz.

G. Design Make: Fluke “DSX-5000” or Approved Equal

H. Acceptable Manufacturers:

1. WaveTek

2. Lantek

2.8 AUDIO/VIDEO (A/V) CABLING AND ACCESSORIES

A. All interconnect audio and video cabling and patch cabling shall be high-resolution shielded type.

B. Audio and video cabling lengths are to be field measured unless otherwise listed.

C. All balanced audio cabling shall be STP type.

D. All full-length cables between active components shall have factory pre-terminated connectors. Field verify cable terminations requirements i.e. (male/male) or (male/female).

E. 3.5 mm Stereo Audio Cables

1. mini stereo jack male connectors on both ends of cable

2. same length as cooresponding video cable

3. Design Make: Extron 26-571-05 or Approved Equal

   a. Bandwidth - 120 MHz @ 50', -3dB, w/.7 Vp-p signal

   b. .24" diameter

   c. Design Make: Extron IN8600P series or Approved Equal

F. HDMI Cabling

1. 4K verified up to 50 feet (15.2 m)

2. 1080p/60 verified up to 200 feet (60 m)

3. Cables up to 50-feet: Supports 4K @ 30 Hz (4096 x 2160), UHD @ 30 Hz (3840 x 2160), and 1080p @ 60 Hz signals, Data rates to 10.2 Gbps, Color depth up to 48 bits - 16 bits per color.

4. Cables up over 75-feet: Exceeds HDMI Standard Speed Cable Specifications, Supports signals up to 1080p @ 60 Hz, 8-bit color depth, Data rates to 4.95 Gbps, Color depth to 24 bits - 8 bits per color.

5. Include required HMDI active equalizer for all cable lengths over 75-feet. Equalizer shall Extends HDMI signals over HDMI cable up to 200 feet, selve powered for cables 125-feet or less. Prove with 120V:12VDC power adapter. HMDI input and output ports.

6. Design Make: Extron HDMI Pro Series w/ HDMI 101 Plus equalizer or Approved Equal

G. USB Cable (3 Meters or Less)

1. Carries USB 3.0 data signals and power; Backwards compliant with high speed USB 2.0 devices (480 Mbps).

2. 3 Meter max. length

3. Up to 4.8 Gbps bandwidth

4. Shielded to protect from interference

5. Black PVC jacket

6. Wall Plate to Wall Plate Connector Types: USB Type A to USB Type A

7. Patch Cable Connector Types for source to peripheral: USB Type A to USB Type B

8. Design Make: Legrand C2G 81XXX Series or Approved Equal

H. USB 2.0 Cable (Up to 75-feet)

1. USB 3.0 extension self-powered active Type Repeater only; not backwards compatible with USB 2.0/1.1

2. Up to 4.8 Gbps bandwidth

3. Shielded optical conversion to protect from interference

4. Black PVC jacket

5. Wall Plate to Wall Plate Connector Types: USB Type A to USB Type A

6. Design Make: Legrand Vaddio 440-1005-XXX Series or Approved Equal

I. USB 3.0 Cable (Up to 75-feet)

1. USB 3.0 extension self-powered active Type Repeater only; not backwards compatible with USB 2.0/1.1

2. Up to 4.8 Gbps bandwidth

3. Shielded optical conversion to protect from interference

4. Black PVC jacket

5. Connector Types for source to peripheral: USB Type A to USB Type B

6. Design Make: Legrand Vaddio 440-1005-XXX Series or Approved Equal

J. Speaker Cable

1. 2 conductor twisted, No. 14 AWG stranded copper

2. Design Make: West Penn Wire Corporation, No. 226

K. Provide Multimedia A/V outlet for all locations shown on the drawings.

1. Provide barrel type jacks for connecting all pre-terminated cable.

2. Provide solder type jacks for audio cable or where bulk cable is required.

3. Wall plates shall be designed for standard 1-gang backbox mounting.

4. The wall plates shall accept the following A/V modules and jacks.

a. Type F coaxial

b. 3.5mm mini stereo jack

c. BNC

d. 3-pin and 4-pin XLR

e. HDMI

f. USB Type A

2.9 ACCESS CONTROL STP CABLING

A. Aluminum foil shield with tinned copper drain wire.

B. Cable shall be UL listed NEC type CMP, constructed in accordance with UL 444. Plenum Rated

C. RS485 Network Wiring: RS-485 standard compliant, up to 4000 feet (1200 m), 22-24 AWG Tinned Copper, FEP (Tefon) insulation, Impedance: 100-120 Ohms Capacitance: 12-16pf/f.

D. Reader Wiring: 3-Pair 22 AWG Shielded

E. Design Make: West Penn or Approved Equal

2.10 LABELING

A. All labels shall be typed on self-adhesive label strips where a plastic protector is not present on the termination equipment.

B. All letters and numbers shall be capital and the same font, black colored text on white background, closest to size 12 ARIAL FONT as possible.

C. Label maker Design Make: DYMO or Approved Equal.

3.0 PART 3 - EXECUTION

3.1 INSTALLATION

A. Horizontal Cable Runs:

1. All interior cabling shall be installed concealed inside the wall cavities and ceiling space.

2. Provide a continuous raceway system in accordance with NEC Article 800 for horizontal cable runs through all inaccessible ceiling (including drywall) and wall cavity spaces. All flexible raceway system runs shall be securely attached to ceiling joists and wall studs 3-feet O.C and removal and addition of cables in the future.

3. UTP Cables shall be supported by independent Cable Hangers 3-foot on center or in Cable Tray. When installed in cable tray Velcro bundle UTP cabling and optical fiber cabling separate from all other system cabling. Provide additional stacked Cable Hangers when filled greater than 50%. Do not install UTP cabling or Optical Fiber Cabling in same cable hanger as fire alarm or speaker cabling.

4. STP Cables shall be supported by Cable Hangers 3-foot on center or in Cable Tray. When installed in cable tray Velcro bundle STP cabling separate from all other system cabling. Provide additional stacked Cable Hangers when filled greater than 50%. Do not install STP cabling in same cable hanger as fire alarm or speaker cabling.

5. In finished locations provide surface raceway for cabling installations from ceiling down to outlet or device where cabling cannot be concealed in construction. Provide conduit to outlet and devices for all exposed no-finished installations in mechanical rooms, gymnasiums, auditoriums, and rooms without accessible ceilings from Cable Hangers and Cable Tray.

6. Refer to specification section 260533 – Raceways for maximum cable fill and supporting hardware specifications.

7. Where larger cable quantities are required to share a single raceway refer to EIA/TIA-569 Conduit Sizing Table 4.4-1.

8. All new device outlets in finished areas shall be flush mounted in the walls.

9. Provide surface raceway for all wiring installations in unfinished areas and conduit for all areas with no ceiling open to the structure.

10. All exterior cabling shall be run in direct buried conduit.

11. Provide separate pathways for all control, video, and signal wiring from 120V branch circuiting.

12. Provide all sleeves as required for routing of cables.

13. Provide firestopping at all firewall and floor penetrations.

14. Do not untwist UTP and STP cable pairs more than 0.5 in. when terminating.

15. Provided inner duct as required to route A/V signal cabling in plenum ceiling spaces. Inner duct shall be 1 ½" diameter, plenum rated, and have pull tape. Design Make: Carlon CH4X1C-350.

16. Cable shall have no physical defects such as cuts, tears or bulges in the outer jacket. Cables with defects shall be replaced.

17. Install cable in neat and workmanlike manner. Neatly bundle and tie all cable in at terminations.

18. Maintain the following clearances from EMI sources.

    a. Power, Fire Alarm, and Audio cable - 6 in.

    b. Luminaires - 12 in.

    c. Transformers - 36 in.

19. Do not install with more than 110N pull force.

3.2 AUDIO/VIDEO CABLING AND ACCESSORIES

A. Provide all required patch cables not shown on the drawings to interface equipment specified in this section.

B. Provide 2'x2' projector plate with extension column above ceiling mount projector location. Prior to rough-in coordinate distance off projector screen or SmartBoard based on the selected projector throw. Independently support the projector plate with support wires to structure above drop ceiling.

C. Cut 2'x4' acoustical ceiling tiles to fit the 2'x2' projector plate. General contractor shall furnish 2' t-bar ceiling accessible bracket to support the half tile and unsupported end of the projector plate.

D. Hang projector from projector plate. Install 120V duplex receptacle flush in knockout in plate. A/V wiring may be run directly to projector and concealed inside 1 ½" pipe column from ceiling down to projector.

E. Connect A/V wiring and power cord to projector.

3.3 UTP CABLE TESTING

A. General

1. All cables and termination hardware shall be 100% tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements of each applicable ANSI/TIA/EIA section listed above for each cable type.

2. All pairs of each installed cable shall be verified prior to system acceptance. Any defect in the cabling system installation including but not limited to cable, connectors, feed through couplers, patch panels, and connector blocks shall be repaired or replaced in order to ensure 100% useable conductors in all cables installed.

3. The testing parameters called for in this section shall apply for up to 90 meters of horizontal cable, a work area equipment cord, an RJ45 outlet and 2 cross connect connections in the closet.

4. The test parameters shall include Wire Map, Length (report only), Attenuation and NEXT.

5. Wire Map - The wire map test shall verify pair to pin termination at each end and check for connectivity errors. The wire map shall indicate the following for each of the eight conductors:

a. Continuity to the remote end

b. Shorts between any two or more conductors

c. Crossed pairs

d. Reversed Pairs

e. Split Pairs

f. Any other miswiring

6. Attenuation - The link attenuation and NEXT of all cables shall be tested. The link is the sum of the attenuation of all connecting hardware, patch and equipment cords, and cable. The following tables indicate the acceptable values:

Attenuation			
Frequency (MHz)	**Category 3 (dB)**	**Category 5e/6 (dB)**	**Category 6A (dB)**
1.0	3.2	2.0	2.1
4.0	6.1	4.1	3.8
10.0	10.0	6.5	5.9
16.0	13.2	8.2	7.5
20.0	-	9.3	8.4
31.25	-	11.7	10.5
62.5	-	17.0	15.0
100.0	-	22.0	19.1
155	-	28.1	24.1
200	-	32.4	27.6
300	-	41.0	34.3
350	-	44.9	37.2
400	-	-	40.1
500	-	-	45.3
625	-	-	51.2

PS Next (worst pair to pair)			
Frequency (MHz)	**Category 3 (dB)**	**Category 5e/6 (dB)**	**Category 6A (dB)**
1.0	40.1	70.3	73.3
4.0	30.7	61.2	64.3
10.0	24.3	55.3	58.3
16.0	21.0	52.2	55.2
20.0	-	50.7	53.8
31.25	-	47.8	50.9
62.5	-	43.3	46.4
100.0	-	40.3	43.3
155	-	37.4	40.4
200	-	35.7	38.8

300	-	33.1	36.1
350	-	32.1	35.1
400	-	-	34.3
500	-	-	32.8
625	-	-	31.4

B. Data reporting and accuracy

1. General: a Pass or Fail result for each parameter shall be determined by the allowable limits for each parameter. If the test result of a parameter is closer to the test limit than the accuracy of the tester it shall be marked with an asterisk. Data at all measured points shall be uploaded to a P.C. and printed on a laser printer.

2. Wire Map: Wire map tests shall be marked "Pass" if wiring is determined correct.

3. Length: Test results shall be reported in meters.

4. Attenuation: Report the attenuation value and the frequency at point of failure or the highest frequency passed. Measured attenuation values lower than 3dB used for a pass/fail determination. Report the attenuation per unit length for links longer than 15 meters. Attenuation shall be measured from 1 MHz to 16 Mhz (Category 3) or 350 Mhz (Category 5e/6) or 500 MHz (Category 6A) in the steps listed in the tables above.

5. NEXT: Report the NEXT value and "pass or fail" for samples based on the following:

Frequency Range (MHz)	**Maximum Step Size (MHz)**
1-31.35	0.15
>31.25-100	0.25

C. Submit copies in binder format and 4 copies on compact disks containing all summary reports, full plot data test results, tester software tools required to view and inspect and print any selection of the test reports, spreadsheets, end to end reports and as built drawings called for at the completion of job.

3.4 LABELING

A. Label each and every termination port for all new cables.

B. Label all new patch panels.

C. Label all new Racks and Cabinets with the CER, Wiring Closet, MDF, or IDF name.

D. UTP Cabling

1. Jack or Outlet termination - All labels shall be typed indicating the CER, Patch Panel Name, and Port Number. Example for CER A, Patch Panel B, port 11: “AB11”.

2. Wiring Closet, Data Closet, MDF, or IDF termination: Label all termination ports with [Room Number]-[Cable Number]. Examples “128-01”, “128-02”, etc. If the cable is run to equipment such as a Fire Alarm Panel or Public Address System label it as [Room Number]-[Equipment Name].

3. Label all Patch Panels in order of top to bottom starting with A.

4. If the UTP cable is run to a separate building, label the UTP Patch Panel with the Building Name in addition to the Patch Panel Name.

E. Optical Fiber Cabling

1. Originating Patch Panel - All labels shall be typed indicating the Destination CER, Fiber Type [MM or SM], and Port Number.

2. Destination Patch Panel - All labels shall be typed indicating the Originating CER, Fiber Type [MM or SM], and Port Number.

3. Label all Patch Panels in order of top to bottom starting with A.

4. If the optical fiber optic cable is run to a separate building, label the Optical Fiber Patch Panel with the Building Name in addition to the Patch Panel Name.

END OF SECTION 271000

SECTION 274116 - INTEGRATED AUDIO/VIDEO SYSTEMS

1.0 PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide all labor, materials, equipment and services required for the installation of a complete and functioning Integrated Audio-Video System.

1.2 SCOPE

A. The following equipment is included as part of this section:

HOMER BRINK ELEMENTARY SCHOOL GYMNASIUM		
Item #	Quantity	Item
1	(9) Wireless Receivers (9) Beltpack Transmitters (3) Handheld Mics. (3) Lavalier Mics.	Wireless Microphone System
2	(3)	Vocal Microphones
3	(3) Round Base	Microphone Stands
4	(1)	Automatic Mixer
5	(1)	Microphone Splitter
6	(1)	Digital Signal Processor
7	(12)	Type A Speaker
8	(22) Receivers Total (6 Hearing Aid Compatible)	FM Hearing Assistance System
9	(1)	Equipment Cabinet
10	(1)	Hinged Protective Enclosure
11	(1)	Blu-ray DVD/CD/MP3 Player
12	(1)	Rack Mount Microphone Splitter
13	As Indicated on Drawings	Audio/Video Wall Plates & Patch Cables and UTP Transceivers

B. Refer to the specification section 271000 for additional horizontal cabling requirements.

1.3 SUBMITTALS

A. Provide catalog cut sheets on all equipment, devices, hardware, etc.

B. Detailed statement of scope indicating contractor, sub-contractor and equipment supplier responsibility. Include which equipment will be provided by each entity.

C. System installers manufacturers certification.

D. Submit proposed rigging design for the hanging speaker array to prior to rough-in. Include all connecting hardware, cabling, and truss and structural attachment hardware cut sheets with live load ratings.

E. Provide shop drawings (minimum 11x17 size) each drawing shall include the drawing number, drawing name, date, Equipment Supplier or manufacturer name. The drawing set shall include as a minimum:

1. Cover Sheet / Revision Record

2. Equipment cabinet elevation showing all components.

3. Riser diagram indicating wire type and quantity required for each device type on the system. Include wire manufacturer part numbers.

4. Equipment interconnect showing where to land each conductor of all field wiring at the equipment cabinet(s). Any custom inter-cabinet wiring shall also be shown on this drawing.

5. Electronic device wiring. Show typical device wiring for each type of device used in the system.

1.4 QUALITY ASSURANCE

A. Equipment furnished under this specification shall be the standard product of one manufacturer with the exception of speakers and surge protection which may be the product of a different manufacturer. All components shall be fully tested and documented to upgrade as a complete system.

B. All equipment furnished under this specification must be installed by, or under the supervision of manufacturer certified personnel.

C. The system supplier shall have a service department within a 60 mile radius and respond to system problems within a 24 hour period. Suppliers shall have been in this business for a minimum of 10 years and must guarantee that spare parts shall be carried in stock for a period of 10 years.

D. All equipment necessary for proper operation of the system though not specifically specified in this section shall be deemed part of the specification.

E. All required maintenance or trouble calls for a period of 12 months from the date of system acceptance shall be provided at no charge to the Owner, unless damage is caused by misuse or abuse.

F. All equipment shall comply with applicable FCC regulations and be UL listed.

G. The Contractor must have completed three similar installations that are currently working satisfactorily.

2.0 PART 2 - PRODUCTS

2.1 WIRELESS MICROPHONE SYSTEM

A. The wireless microphone system shall include all components for a functional system. The system shall allow the instructor or presenter to wear a miniature lavalier style microphone or headset microphone that transmits the speech to a body pack then via. RF to a receiver in the equipment cabinet. The system shall also include wireless handheld microphones. The RF receiver shall connect to the mixer with a ¼" Phono to 3-pin XLR line matching transformer.

B. The system shall include the following components:

1. Lavalier Microphone
    a. Omindirectional subminiature condenser type w/ tie-clip
    b. 4-foot cable with 4-pin connection to transmitter
    c. Includes windscreen and clip-on bar
    d. Frequency Response: 50 – 20kHz
    e. Design Make: Shure WL183 or Approved Equal
2. Ear Piece Microphone
    a. Omindirectional pick-up pattern microphone
    b. Single wraparound low-profile ear-piece
    c. Black shielded cord with mini 4-pin connector (TA4F)
    d. Design Make: Shure Countryman WCE6 or Approved Equal
3. Guitar Pick-up Cable
    a. Includes right angle ¼" guitar connector and 2-foot instrument cable
    b. Design Make: Shure WA304 or Approved Equal
4. Body-pack Transmitter
    a. External power switch, Mute switch, & Gain control knob
    b. Power on & Low battery indicator
    c. RF Carrier frequency: 470.000 to 865.000 MHz
    d. TA4F mini four-pin input connector
    e. 9 Volt battery operated (18 hour battery life)

f. External flexible antenna

g. Belt clip

h. Design Make: Shure SLXD1 or Approved Equal

5. Wireless Handheld Microphone

a. Cardioid (unidirectional) dynamic

b. Frequency response: 50 to 15,000 Hz

c. Wireless transmitter in base w/ adjustable gain control

d. Input Attenuation Switch-Select 0dB for Voice/Low Output; 20dB for High Output

e. Design Make: Shure SM58 Cardioid Microphone w/ SLXD transmitter or Approved Equal

6. RF Receiver

a. External power switch, Mute switch, & Squelch control know

b. Power on & RF signal indicator

c. Includes 120V power adapter

d. Single Telescoping antenna

e. ¼" Phono jack audio output (unbalanced, high impedance)

f. Design Make: Shure SLXD4 or Approved Equal

7. Line Matching Transformer

a. ¼" Phone input

b. 3-pin XLR output

c. Include with rack mount kit for each SLXD receiver.

d. Include with antenna combining kit and external mount remote antennas as called for on drawings, Shure UA844SWB or Approved Equal

e. Design Make: Shure UA507 or Approved Equal

8. Antenna/Power Distribution System

a. Design Make: Shure UA844 or Approved Equal

9. UHF Active Directional Antenna

a. Design Make: Shure UA870WB

2.2 VOCAL MICROPHONES

A. Die cast metal handle. Dark gray matte finish. Silver colored, spherical steel mesh grille.

B. Frequency Response: 50 – 15,000Hz

C. Output Impedance: 300 Ohms

D. Output Level (at 1000Hz): -54.5 dBV/Pa (1.85 mV)

E. Connector: 3-pin male XLR type

F. Design Make: Shure SM58 or Approved Equal

2.3 MICROPHONE STANDS

A. Desktop stands

1. 6” diameter base

2. 5” stand height

3. Base material: Cast iron

4. Finish: Black with chrome tube

5. Weight: 3 lbs

6. Design Make: Atlas Sound DS5 or Approved Equal

2.4 SPEAKER ASSEMBLIES

A. Type A Speaker

1. 5.25-inch, two-way, coaxial, open-ceiling speaker

2. Frequency Range (-3 dB): 87Hz – 22kHz

3. Sensitivity (1W @ 1m): 86.5 dB

4. System Power Handling: 75W continuous, 150W program

5. Nominal Impedance: 8 ohms

6. Coverage Angle (-6dB @ 2kHz): 75°

7. Coverage Angle (-6dB @ 10kHz): 105°

8. Coverage Angle (averaged 2-10kHz): 95°

9. Transducer – Low Frequency Driver: 133mm polypropylene cone, rubber surround

10. Transducer – High Frequency Driver: 25mm titanium with BroadBeam waveguide

11. Low-Frequency Voice Coil: 25.4mm

12. Crossover Frequency: 3kHz

13. Enclosure Material: Injection-molded ABS, glass fiber reinforced

14. Grille: Iridite-plated steel with powder-coat finish

15. Inputs: Four-pin, 5.08 mm Euroblock for individual or daisy chain connection

16. Color: White.

17. Height: 11.74”

18. Diameter: 9.68”

19. Weight: 9.5 lbs

20. Design Make: Soundtube RS500i

2.5 DSP/AMPLIFIER/MIXER

A. Powered digital signal processor

B. Eight Inputs

C. Each input shall have individual mute capability.Each input shall have six processing blocks configurable for Dynamics (ambient noise compensation, compressor/limiter, auto-leveler, ducker, gate, Gain (including Group VCA and remote gain), Equalization (31-band graphic, parametric X 10, feedback suppressor) Crossover, Delay, Metering, and Signal Generator (sine wave, pink noise, white noise)

D. The routing stage shall allow the user to assign an input to any or a combination or outputs and separately adjust how much signal level goes to each output (matrix mixer). The maxtrix mixer shall also have selectable gain-sharing automatic mixing capability.

E. Each input stage shall have an additional preamp output (post DSP) on the back panel.

F. Eight powered outputs shall deliver 150W @ 8ohms, 250W @ 4ohms, and channel pairs can be bridged for 500W @ 8ohms.

G. Frequency response: +/- 1 dB from 20 Hz to 20 kHz

1. Signal to Noise (20Hz – 20kHz): > -102dB

H. Provide with rack mounting kit.

I. Design Make: Ashly PEMA 8250

2.6 FM HEARING ASSISTANCE SYSTEM

A. FM Hearing Assistance System shall consist of one transmitter with antenna, audio cable and power supply, receivers with batteries and mini "earbud" earphones, and a wall plaque.

B. Transmitter Specifications:

1. Microphone inputs: two low-impedance, unbalanced, 1/4" phone jack.

2. Input Level: Dynamic Mics: 250uV to 25mV. Electret Mics: 1mV to 100mV, phantom powered.

3. Line Inputs: One balanced bridging, 10K impedance, Female XLR. One unbalanced, 100K impedance, RCA jack.

4. Input Level: 0.03 to 1V RMS, nominal.

5. Automatic Gain Control: 40dB range, 30mV threshold.

6. Input attenuator: 3 positions, OdB, -20dB, -40dB.

7. Low frequency attenuator: 6dB/octave, 3 positions: "O"=-3dB at 20Hz, "1"=-10dB at 80 Hz, "2"=-10dB at 240 Hz.

8. Tape output: 1K impedance, 1/4" phone jack.

9. Tape out level: 1V into 5K ohms, at threshold of AGC.

10. Monitor jack: 8-32 ohm load, 3.5mm jack.

11. Max. RF power supplied to final RF stage: 250 mW.

12. Max. transmitted field strength: 800uV/m at 30m.

13. Transmitter range: 300 ft. typical.

14. Operating Frequency: Channel (E) 72.9 Mhz standard; Alternates: Channel (A) 72.1, (F) 75.5, (H) 75.9 Mhz.

15. Frequency Tolerance: ±0.005%.

16. Maximum deviation: ±75khz.

17. Pre-emphasis: 75 mS.

18. S/N ratio: 55dB.

19. Power requirements: 100-130 VAC, 1 watt; 6-foot 3-wire grounded cord/plug. 12V DC at 75mA.

20. Antenna: 80" half-wave coaxial, integral with 50 ft. RG 59 coax cable, "F" connector.

C. Receiver Specifications:

1. Battery type: 9 volt.

2. Battery Drain: 12mA idle, 20mA average.

3. Battery Life: 10 hours, typical.

4. FCC approval: Accepted by Notification, FCC Part 15.

5. Frequency: 72-76 mHz

6. 1F: 70 kHz.

7. De-emphasis: 75mS to match transmitter.

8. FM Deviation: ±75kHz, max.

9. AFC range: ±300kHz.

10. Sensitivity: 2uV for 12dB Sinad with squelch defeated.

11. Input overload: 20mV.

12. Squelch threshold: 8-10uV.

13. S/N ratio: 10uV produces 50dB quieting.

14. Antenna: Integral with earphone cord.

15. Controls: Combination volume with on/off control.

16. Indicators: Red "on" indicator.

17. Audio Frequency Response: 40Hz to 15kHz ±3dB.

18. Audio Output: 250mW max into 16 ohms.

19. Output load: 8-16 ohms.

20. Output connector: 3.5mm phone jack, mono.

21. Distortion: 1.5% THD at rated output.

22. Acoustic output: 130dB SPL max. with EAR 013, at 250mW output.

D. Design Make: Williams Sound PPA VPE Value Pack System consisting of PPA T17 transmitter and PPA R7 receivers and all accessories for a complete operating system or Approved Equal.

2.7 POWER CONDITIONER

A. Maximum output current: 15Amps

B. Line Cords: 6-ft, 14AWG, with 3-conductor Edison plug

C. Operation voltage: 120VAC, 60Hz

D. Spike protection mode: Line to neutral

E. Energy dissipation: 150 Joules

F. Peak impulse current: 12000Amps

G. Noise Attenuation: Greater than 26dB, 200KHz to 10MHz

H. Design Make: Furman M-8DX or Approved Equal

2.8 MEDIA PLAYER

A. Rack mountable CD/USB/Bluetooth player.

B. Supported Media:

1. CD, CD-R, CD-RW

2. 3.5 mm auxiliary device

3. Type A USB device

4. Network-connected device (via Ethernet port)

5. Bluetooth audio

C. Connectors:

1. Input:

a. AUX In (Unbalanced): 1/8” (3.5mm) TRS terminal

2. Outputs:

a. Analog Output (Unbalanced): RCA pin jack

b. Analog Output (Balanced): XLR 3-32 jack

D. Bluetooth:

1. Version 4.0

2. Output class: Class 2

3. Supported profile: A2DP, AVRCP (1.3/1.4)

4. Supported A2DP codecs: SBC, MP3

5. Bluetooth Range: 82ft/25m

6. A2DP content protection: SCMS-T

7. Include (2) external Bluetooth antennas

E. Includes remote control.

F. RS-232C connector for control

G. Operates off internal 120V power supply.

H. Design Make: Denon DN-700CB or Approved Equal

2.9 AUDIO TAKE-OVER RELAY

A. Provide voice activated take-over relay for sound system as indicated on the risers. Relay shall mute sound system program source and allow broadcast of public address system signal.

B. Includes set of N.O. and N.C. contacts.

C. Activates when audio signal is detected at the microphone pre-amp or at 70V, 25V, or 600-ohm line level inputs.

D. Design Make: Bogen Model VAR1 or Approved Equal

2.10 AUDIO/VIDEO WALL PLATES AND PATCH CABLING

A. Audio and video cabling lengths are to be field measured unless otherwise listed.

B. Category 6 cable may be used for unbalanced RCA audio cabling where the distance does not exceed 30 feet.

C. All balanced audio cabling shall be STP type.

D. All full-length cables between active components shall have factory pre-terminated connectors. Field verify cable terminations requirements ie. (male/male) or (male/female).

E. Video cabling shall meet the following requirements:

1. VGA Video cabling

a. Jacket Rating: Plenum

b. Up to 150-foot lengths without the use of USB or AC power extenders.

c. Contractor shall verify exact length required for installation.

d. Design Make: Legrand Quiktron RapidRun Multi-Format cable with wall plate and flying lead at each end.

2. HDMI Cabling

a. Jacket Rating: OFNP (Plenum)

b. Supports full 1080p, 4K, 3D resolutions

c. Supports HDMI 2.0 resolution and bandwidth

d. Up to 1000 foot lengths. Powered with USB at the display side, which allows the source side to be clean of excess cables. Provide USB cable as required.

e. Contractor shall verify exact length required for installation.

f. Design Make: Legrand Quiktron RapidRun Optical cable with wall plate and flying lead at each end.

3. 3.5 mm Stereo Audio Cables

a. Mini stereo jack male connectors on both ends of cable

b. Contractor shall verify exact length required for installation.

c. Design Make: Extron 26-571 or Approved Equal

4. Shielded Twisted Pair Audio Cable (STP)

a. Single Pair STP

1) Each pair shall be individually shielded with 100% aluminum foil shield conductor

2) FEP insulated, twisted pair.

3) ASTM tinned copper 22 AWG (7x30) tinned copper red and black conductors.

4) Cable shall be UL listed NEC type CMP, constructed in accordance with UL Standard 4444 and comply with UL 1666 vertical shaft flame test.

5) Cable shall be fully functional from -20°C to 75°C.

6) Grey Jacket

7) Design Make: West Penn D25454 or Approved equal

b. Two Pair STP

1) Same as above description except with two individual STP cables in common non plenum rated jacket

2) Design Make: West Penn 201454 or Approved equal

c. Speaker Wire

d. 2 conductor twisted, No. 14 AWG (19x27) stranded copper insulated red and black conductors.

e. Overall UL listed NEC type CMP jacket

f. Design Make: West Penn 25226B or Approved Equal

F. Provide the following cable adapters as required:

1. 3.5mm mini stereo male to (2) RCA female: Design Make: Extron IN9090

2. Wired microphone cable to XLR adapters

G. Provided inner duct as required to route A/V signal cabling in plenum ceiling spaces. Inner duct shall be 1 ½" diameter, plenum rated, and have pull tape. Design Make: Carlon CH4X1C-350.

H. Provide A/V Wall plates at all Multimedia A/V outlet locations shown on the drawings.

1. Wall plates shall be modular in design and accept up to (4) separate A/V modules. Modules may hold more than one jack depending on the part number.

2. Provide barrel type jacks for connecting all pre-terminated cable.

3. Provide solder type jacks for audio cable or where bulk cable is required.

4. Wall plates shall be designed for standard 1-gang backbox mounting.

5. The wall plates shall accept the following A/V modules and jacks:

a. RCA stereo audio

b. 3.5mm mini stereo jack

c. 75Ω BNC

d. 3-pin and 4-pin XLR

e. RCA audio and video with separate colors

6. HD15-pin VGA (male/male) and HD15-pin VGA (female/female)The A/V wall plates shall be as shown on the drawings.

a. VGA (HD15) female jack in decorative style wall plate. Provide with multi-format orange runner. Design Make: Legrand Quiktron RapidRun 2212-60058-001.

b. HDMI female jack in decorative style wall plate. Provide with optical runner and receiver flying lead. Design Make: Legrand Quiktron RapidRun 2212-60150-001.

c. SpeakOn female jack. Provide with connector. Design Make: Neutrik NL4MP-ST jack with NL4FC connector.

7. Acceptable Manufacturers:

a. Extron

b. Legrand Quiktron

2.11 AUTOMATIC-MIXER

A. 8-channel automatic analog sound mixer with eight (8) balanced mic-line input channels.

1. Takes up to eight (8) microphone inputs and sends one (1) output back to mixer.

B. One (1) unbalanced 1/4” auxiliary input level control.

C. Eight (8) unbalanced 1/4” direct line level outputs.

D. One (1) main block connector output.

E. 48-volt phantom power for eight (8) channels.

F. Low-Cut Filter, High Frequency Shelving/Channel.

G. Dimensions: 1.75”H x 19”W x 12.5”D

H. Design Make: Shure SCM810 or Approved Equal

2.12 EQUIPMENT CABINET

A. Equipment cabinet shall include base with wiring access holes and conduit knockouts; top panel with knockouts; louvered side panels; louvered rear door with lock handle and spring loaded hinges; channel slides, one pair of front to rear adjustable mounting rails tapped to 1032; panel mounting screws and assembly hardware; front door with cylinder lock.

B. Equipment cabinets shall house audio system equipment as shown on Gymnasium Sound System Riser Diagram.

C. Provide lockable storage drawers for storage of microphones and FM hearing assistance system components (quantity as shown on Auditorium Sound System Riser Diagram).

D. Provide blank panel with drilled openings and antennas for remote mounted wireless microphone transmitters and FM hearing assistance system.

E. Provide blank filler panels for unused rack openings.

F. Provide and connect (2) 8-outlet plug strips with surge and noise suppression inside of equipment rack.

G. Design Make: Middle Atlantic Products, Inc. ERK Series

2.13 HINGED PROTECTIVE ENCLOSURE

A. Aesthetic styling, with an attractive, durable powder coat light-gray finish with outward formed flange to prevent contaminants from entering the enclosure.

B. Custom Fabricated Dimensions: 14” High x 11” Wide x 4.72” Deep

C. Flush-mounted 4.8-mm (3/16-in.) thick impact resistant clear polycarbonate window door, hinged solid door and solid screw cover.

D. Key locking front cover.

E. Housing Construction: (16 gauge) steel with all seams continuously welded and ground smooth

F. Design Make: Hoffman / NVent INLINE, TYPE 4 LWC Series or Approved Equal

2.14 AUDIO/VIDEO UTP TRANSCEIVERS

A. HDMI over UTP Transceivers shall be provided for all HDMI cable lengths over 50-feet

B. System shall be composed of a compatible transmitter and receiver pair.

C. Technical requirements:

1. Frame rate: 24, 25, 30, 50, or 60 fps

2. Chroma sampling: 4:4:4, 4:2:2, or 4:2:0

3. Color bit depth: 8 bits per color

4. Signal Type: HDMI 1.4, HDCP 2.3

5. Max. video data rate: 10.2 Gbps (3.4 Gbps per color)

6. Provide HDMI over UTP active transmitter and receiver all cable lengths over 50-feet. Equalizer shall Extends HDMI signals over HDMI cable up to 200 feet, self powered for cables 125-feet or less. Prove with 120V:12VDC power adapter. HMDI input and output ports.

D. Signal transmission distance

1. 1080p @ 60 Hz: Up to 230' (70 m) using shielded twisted pair (STP) cable or XTP DTP 24 cable

2. 2560x1600 @ 60 Hz : Up to 130' (40 m) using STP cable or XTP DTP 24 cable

3. 4K/UHD @ 30 and 60 Hz: Up to 130' (40 m) using STP cable or XTP DTP 24 cable

E. White finished 1-gang faceplate with HDMI type A connectors

F. Design Make: Extron DTP T HWP 4K 231 D and DTP T HWP 4K 331 R or Approved Equal

3.0 PART 3 - EXECUTION

3.1 GENERAL

A. The manufacturer shall supply all information for the system wiring.

B. The sound system drawings are schematic. The system manufacturer shall incorporate their wiring requirements on the system drawings. The contractor shall be responsible, in conjunction with the system manufacturer for complete wiring requirements and conduit sizes.

C. Provide all required rigging for speaker arrays. Install the multiple curvilinear array loudspeakers in a flown configuration. In flown configurations, the first loudspeaker in the array can be connected to the grid at 0, -5, or -10 degrees with respect to the grid. The uptilt and downtilt can be adjusted using chain motors or different lengths of steel. Provide with necessary amount of Quick-Release pins. Provide with all necessary rigging and cable required for appropriate installation of multiple speaker arrays. Provide required steel truss mounting hardware. Rigging and the support of array shall be designed by a certified theatrical rigging contractor. The final design shall include a 4.0 safety factor.

3.2 INSTALLATION

A. Install all equipment shown on plan. Verify the exact location of all devices on architectural ceiling plans and elevations or with existing construction.

B. Install audio system cabling in one of the following pathways:

1. Supported with velco strips to “D-rings” where traveling on vertical walls. Provide “D-rings” 2-feet on center.

2. Supported 4-feet on center from 1” wide “J-hooks” in mechanical rooms and basements or above non air-plenum ceilings.

C. Where surface raceway is required, paint to match existing walls.

D. After system has been completely tested, “dress out” the central equipment rack. Neatly bundle all cable with nylon cable. Provide sufficient loop in the cable bundle to allow moving the cabinet away from wall for maintenance, repairs and additions.

3.3 SYSTEM TESTING AND ADJUSTMENTS

A. Provide up to (6) individual presets for the Digital Signal Processor. Coordinate the inputs, outputs, equalization, delay, and gain settings for each preset with the owner. The DSP settings shall include selections from a simple stage presenter to a full production mixing setup.

B. Before final acceptance of the system, the Contractor, in the presence of the Owner’s representative, shall test each and every component and device in the system. Test shall be documented with signed copy submitted to the Owner and Architect/Engineer.

C. Field adjust initial volume levels and delay setting on digital signal processor based on field conditions and room acoustics. Provide (8) additional hours of on-site adjustments after the system has been installed an tested.

D. Upon completion of the system installation, it shall be the responsibility of the Contractor to perform the necessary adjustments and balancing of all signals and amplifier level controls to insure proper system operation.

E. The system shall be physically inspected by the Owner’s representative and the Architect/Engineer to assure that all equipment is installed in a neat and workmanlike manner as called for in the plans and specifications.

F. As a minimum requirement, the internal intercommunication system should be tested to prove the following:

1. The complete sound system is free from grounds, opens and shorts.

2. Each device function as specified herein.

3. Proper adjustment of all speaker taps to provide clearly audible, but unobtrusive paging in all areas.

G. Fill out test report at the end of this section.

H. The Contractor shall be responsible for minor system adjustments such as tap changes, signal balancing, etc., for a period of one year after system acceptance. Respond to a call from the Owner within 48 hours. These adjustments shall be performed at no additional cost to the Owner.

I. Provide authorized technician to program the existing building PA system to interface the new take-over relay cable. Provide required terminations on the existing building PA system.

3.4 OWNER TRAINING ON SYSTEMS OPERATION

A. Upon completion of the work, and prior to acceptance of the same by the Owner, the Contractor and major equipment manufacturer's qualified representative shall spend a reasonable amount of time, instructing them on the operation and service of all the sound system equipment and controls.

B. The Contractor shall properly instruct maintenance personnel to perform emergency repairs to the system such as replacement of defective standard components such as loud speakers, amps, etc.

C. Provide (2) separate three-hour training session for building personal managing the auditorium spaces.

D. Place sign-in sheet from training in final O&M Manuals.

3.5 INSTRUCTION MANUALS

A. The Contractor shall provide, in addition to the approved copies of the public address/intercom/clock system submittals, complete written operating instructions, pertinent system orientation documents, and system service and parts list and testing documentation.

B. The Contractor shall provide four complete sets of service manuals and wiring diagrams of the entire system, including manufacturer's parts and numbers, schematics, complete with operating information, including equipment characteristics, operating voltages, etc.

3.6 WARRANTY

A. Provide one-year warranty on all parts and labor.

B. The warranty shall take effect after the Owner has accepted the system.

END OF SECTION 274100

SECTION 275117 - IP PUBLIC ADDRESS SYSTEM

1.0 PART 1 – GENERAL

1.1 WORK INCLUDED

A. Provide all labor, materials, tools, software, licensing, and equipment required for the complete installation of work called for in the Contract Documents.

B. Refer to specification section 271000 - Horizontal and Backbone Communication Cabling for speaker and hardware interconnection cabling.

1.2 SCOPE OF WORK

A. Expand the existing Rauland Telecenter U IP Public Address system to the new addition and renovation areas. Provide additional POE+ switches as required to accommodate the quantity of new speakers.

B. This section includes a fully operational IP to Analog Public Address System, including but not limited to the following:

1. The system shall provide complete internal communications utilizing IP communication between system components.

2. Two-way Loud Speaking Internal Intercommunications.

3. Event Announcement.

4. Auxiliary I/O Push Buttons to provide room check in or trigger lock down events or alarms to 3rd party systems.

5. Emergency announcement that will override any pre-programmed zones assuring that all Emergency/Lockdown etc. are heard at each and every speaker location.

6. Capability of prerecording emergency announcements that can simply be activated by a smart phone application, PC software, or via a dedicated call-switch.

7. Paging and Emergency tones.

8. Distributed LAN network architecture capable.

9. Paging and Zone Program Distribution.

10. Ability to use analog amplifiers to drive analog speakers from a IP source.

11. Ability to use analog power amplifiers to support high output outdoor speaker zones or large venue speakers for gymnasiums and auditoriums.

12. Incorporate district-wide announcements, either live or recorded thru a direct connection to the LAN.

13. Shall support Ethernet communication from other servers and SIP based devices to allow for announcements across a campus or multiple buildings.

C. Time Control and Programmed Announcements

1. Class change signaling

2. Network time synchronization with Class Change Tones utilizing multiple, programmable schedules for each zone.

3. Emergency call-ins shall take precedence over normal calls so that they are answered first. The system shall support a minimum of 16 call level priorities which shall be user definable.

4. Any authorized administrator shall be able to call form outside the school into any classroom, zone or entire school directly via the owners VOIP Telephone System. This shall allow remote monitoring and two-way conversation form outside the school building as well as Paging into the system. The feature shall allow the user access to all functions via a user defined PIN code. (Compliance with NEMA Standard SB-40 for emergency communications in K-12 Schools.)

5. Authorized system users shall be able to record a minimum of ten (10) automated messages with emergency instructions and replay them. Automated message strings shall be either automatically distributed as part of a dial string, manually played from a single-button access on the phone or thru the master clock as a timed event.

6. Paging and two-way loud speaking features shall be accessible from any telephone by authorized users with the use of a user defined PIN code.

7. The system shall allow the users to exclude their classrooms from paging and tones in the event of testing or other activity that shouldn't be interrupted. This exclusion will not affect emergency paging. The "exclusion" must have the ability to "reset" at midnight.

8. The system shall synchronize its system time to the network timeserver or a web-based time server.

9. This specification establishes a minimum level of quality, features, and performance for individual components as well as the integrated system.

10. The system shall incorporate Ethernet LAN based functionality to permit control of Public Address functions by an authorized user from an internet browser. The system shall also permit access to any other same system installation on the LAN. All browser-based access shall be secured by passwords.

1.3 SUBMITTALS

A. Product data for each component.

B. Shop Drawings: Prior to proceeding with the work: Provide detailed equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, location of each field connection, and a complete schedule of all equipment and materials with associated manufacturers cuts sheets which are to be used.

C. Wiring Diagrams: Detail wiring for power, signal, control systems and differentiate between manufacturer-installed and field-installed wiring. Identify terminals to facilitate installation, operation and maintenance. Include a single-line diagram showing cabling interconnection of components and levels throughout system and impedances.

D. Details and description of any other aspect of the system, which must differ from the contract documents due to field conditions or equipment, furnished.

E. Installer Certificates: Signed by manufacturers certifying that they comply with requirements.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who is an authorized representative of equipment manufacturer for both installation and maintenance of equipment required for this Section. Provide the following within thirty (30) days after notification to proceed:

1. Provide a list of installations that the Installer has specifically installed for verification by the Owner. Random installations from other vendors and/or Installers shall not be accepted. The Installer, not its employees, must meet these qualifications.

2. The Installer shall demonstrate to the satisfaction of the Owner or his representative that he has:

a. Adequate plant and equipment to pursue the work properly and expeditiously.

b. Adequate staff and technical experience to implement the work.

c. Suitable financial status to meet the obligations of the work.

d. Technically capable and factory trained service personnel at local service facility to provide routine and emergency service for all products used in this project.

B. Because the life expectancy of this type of communications system normally exceeds 10 years, the owner expects continuity from the service provider. Therefore, the installing/servicing company must have been an authorized provider of the manufacturer’s product for at least 10 years.

C. Each major component of equipment shall have the manufacturers name, address and model number on a plate securely affixed in a conspicuous place. NEMA code ratings, UL Label, or other data that is die-stamped into the surface of the equipment shall be easily visible.

D. Comply with NEMA Standard SB-40 for Emergency Communications in K-12 schools.

2.0 PART 2 - PRODUCTS

2.1 SYSTEM REQUIREMENTS

A. The system shall utilize IP technology, Call-in Notification, School Safety Paging and Evacuation tones, Distributed LAN Architecture, Network Time Synchronization with Class Change Tones utilizing multiple, programmable schedules for each zone, Two-way Loud Speaking Internal Intercommunications and Paging, and Program Distribution. The system shall be easy to learn and operate. All standard system programming shall be user friendly to allow the system administrator the ability to easily program system features.

B. Provide complete and satisfactorily operating school communications and School safety as described herein, using materials and equipment of types, sizes, ratings, and performances as indicated. Use materials and equipment that comply with referenced standards and manufacturers' standard design and construction in accordance with published product information. Coordinate the features of all materials and equipment so they form an integrated system, with components and interconnections matched for optimum performance of specified functions.

C. The system shall be single electronic system consisting of amplified intercom channels depending upon the configuration of the system, (classroom) speakers, corridor speakers, inside and outside horns, call-in switches, and master clock.

D. Feature offered by this system shall be implemented and controlled by a software program that can be changed and expanded as customer need evolve.

E. The system shall lend itself to expansion by simple addition of hardware modules.

F. The system shall allow the implementation of bell schedules that are managed via the WAN/LAN. The system shall directly connect to the WAN/LAN without the need for a separate computer at the school location. Bell schedules can remotely be created, changed, stored and downloaded to the system by an authorized user from a browser-based interface.

G. The system shall provide the ability to initiate school safety paging announcements, evacuation tones and take cover tones from any telephone within the facility or outside the facility to any other location within the facility. The system must also allow the implementation of a district-wide announcement system, where live messages, pre-recorded announcements and emergency tones can be triggered via a telephone or browser-based user interface.

H. The system shall provide the ability to selectively communicate or monitor individual classrooms in emergency situations from any telephone within the facility or outside the facility to any other location within the facility; all communication within the classroom shall be hands free and will not require any interaction by the end-user to answer.

I. Room speakers, call switches, shall be programmable and may be assigned any two, three four or five digit number. Any extension may be reassigned at any time, and it shall not be dependent on wiring or circuit numbers.

J. Amplified two-way voice communication shall be available from any provided telephone through any speaker in the system. This shall allow hands-free communication to any classroom or any individual loudspeaker unit. A programmable pre-announce tone shall sound immediately before the intercom path is opened and a supervisory tone shall continue to sound at regular intervals when speaker monitoring is active, complying fully with all privacy legislation.

K. Integrated Master Clock with unlimited schedules, unlimited events, and automatic Daylight Savings time correct. Up to 5 schedules may be active on any given day. User shall be able to select form 15 tone options or user created .wav files for class change signaling. In addition the system shall allow unlimited user defined class change tones to be recorded. The system shall allow control of the bell schedules via the district WAN/LAN. The system shall directly connect to the WAN/LAN without the need for a separate computer at the school location. Bell schedules can remotely be created, changed, stored and downloaded to the system by an authorized user from a browser-based interface.

L. Ability to correct and power secondary clocks using the same Cat/6 cable drop (district standard) used for intercom speaker, call switch and (optional) motion detector.

M. Web based connectivity for browser-based access and control of PA System.

2.2 ANALOG INPUT MODULE

A. Converts analog audio signals to IP based audio

B. Output: RJ-45 100Mb/s Ethernet

C. Input:

1. 3.5mm stereo jack

2. Input audio signal 0.5V to 1.228VRMS max

D. Provide with 1U rack mounting kit as required

E. The system shall provide facilities to distribute program material (i.e. cassette tape, CD, radio broadcasts) in the following manner:

1. The user shall cue remotely located music source or select radio station.

2. From an Administrative Telephone the user can select the room(s) or areas to distribute program.

3. Automated distribution based on event schedule.

F. Design Make: Rauland TCC2055 or Approved Equal

2.3 ZONE PAGING MODULE

A. Decodes IP based audio signals to analog audio for local playback

B. Analog audio output can be fed to traditional external audio amplifiers to extend paging coverage to larger areas

C. Output

1. Analog Audio

a. 1.0 VRMS +/- 20%

b. 300-3.3k Hz

2. Relay

a. DPDT

b. 5A at 125VAC or 5A at 30VDC

D. RJ-45 Ethernet connection; Power Over Ethernet (POE) 802.3af

E. Include with 1U rack mounting hardware

F. Design Make: Rauland TCC2022 or Approved Equal

2.4 AUXILIARY I/O PUSH BUTTON INTERCONNECT MODULE

A. Provides dual input and dual output contact closure points to control external devices.

B. Provides interface to external systems such as cameras or security monitoring.

C. Facilitates room check in status or control of external devices such as alert lights/strobes, provides the ability to connect a panic button to the system.

D. Digital encryption of all control signals for excellent security.

E. RJ-45 Ethernet connection, 802.3af Power Over Ethernet compatible.

F. Includes rack mounting hardware

G. Design Make: Rauland TeleCenter U Auxiliary Input/Outout Module TCC2033

2.5 4-CHANNEL POWER AMPLIFIER

A. 4-Channel analog output audio amplifier.

B. The output circuitry shall be Class D, convection cooled with a frequency response of 20Hz to 20kHz ±1.0dB, -3dB @ 80Hz due to HPF.

C. Signal-to-Noise shall be greater than 100dB unweighted.

D. The front panel shall provide the status of power, standby, protect, signal level and clip. The amplifier shall mount in a standard 19 inch rack using two spaces (3.5" high) and weigh 30 pounds.

E. Power Output Requirements:

4 Ohms	150W
8 Ohms	80W
25V (per channel)	150W
70V (per channel)	150W
100V (per channel)	150W

F. Rear I/O Connectros: Input: 3-Pin Euroblock Output: Euroblock

G. 2U rack units high, Includes rack mounting hardware

H. Internal 120VAC power supply

I. Design Make: Ashley Audio TRA-4150 ort Approved Equal

2.6 POE+ ETHERNET SWITCH

A. IEEE 802.3i 10BASE-T, I EEE 802.3u 100BASE-TX, I EEE 802.3ab 1000BASE-T Gigabit Ethernet compliant

B. Dedicated AV web-based GUI interface for more specific AV installations

C. Supports Dante video profiles

D. Feature set includes static, RIP and PIM routing, DHCP Server and PTPv2

E. Gigabit speed with QoS, VLAN and network monitoring

F. Power wireless access points or other IEEE P802.3af compliant +POE-capable devices

G. Support for 100 VLANs

H. Web managed via. GUI

I. 24-port capacity, RJ-45 connectors

J. Includes 480 Watt, 120V power supply

K. Provide with 19” wide rack bracket kit

L. Design Make: Netgear M4250-26G4XF-PoE+or Approved Equal

2.7 SPEAKERS

A. Interior Recessed Mounted Speaker

1. Provide premium quality 8” cone transducer speaker. Transformer assembly shall be dual voltage multi-tap type suitable for 25 or 70-volt installations. The speaker shall have a frequency response of 65 Hz to 17 KHz with a power rating of 8 watts. Sensitivity shall be 93 dB, 1 watt, 1 meter. Voice coil shall be ¾” diameter with a 5 ounce magnet. When installed in ceiling, no speaker assembly weight shall be resting on any ceiling tiles. Include accessible volume control attenuation knob on outside and center of grill.

2. The baffle shall be constructed of a one-piece, 22 gauge cold-rolled steel, zinc-treated to prevent corrosion. The finish shall be white baked powdered epoxy and be virtually scratch/mar proof. The baffle perforation pattern shall be designed for wide sound dispersion and screw attachment to top of the back box.

3. Design Make: Bogen or Approved Equal

B. Interior Surface Mounted Speaker

1. Provide premium quality 8” cone transducer speaker. Transformer assembly shall be dual voltage multi-tap type suitable for 25 or 70-volt installations. The speaker shall have a frequency response of 65 Hz to 17 KHz with a power rating of 8 watts. Sensitivity shall be 93 dB, 1 watt, 1 meter. Voice coil shall be ¾” diameter with a 5 ounce magnet. When installed in ceiling, no speaker assembly weight shall be resting on any ceiling tiles.

2. The surface mount clock/speaker back box shall be of 22 gauge cold-rolled steel, with baked powdered epoxy white finish.

3. The back box shall be 12”x12”x5” deep and shall be capable of accommodate flush mounted speaker.

4. Design Make: Bogen or Approved Equal

C. Interior/Exterior Wall Mounted Horn Speaker

1. Provide double re-entrant type horn loudspeakers with integral driver. The horn loudspeaker shall be impervious to weather and vandalism. Horn shall be constructed of heavy-duty ABS plastic. Horn loudspeaker drivers shall be rated at 15 watts with a frequency response of 480 Hz to 14 KHz. Sensitivity shall be 106 dB 1 watt, 1 meter. Transformer assembly shall be dual voltage multi-tap type suitable for 25 or 70-volt installations. Dispersion patter shall be 180 degrees conical. The horn loudspeaker shall be constructed of treated heavy gauge aluminum, with all exposed p arts potted and sealed driver. Wiring terminal shall be fully enclosed. The speaker flange and mounting surface shall have a cork-rubber gasket. The horn loudspeakers finish shall be gray baked on enamel.

2. Indoor/outdoor weatherproof construction.

3. Design Make: Bogen or Approved Equal

3.0 PART 3 - EXECUTION

3.1 INSTALLATION

A. Server and Controller setup:

1. Configure all Microsoft and PA System software patches and updates.

2. Install anti-virus on the server.

3. Install all manufacturer required SQL server features and windows services.

4. Install the server in a server cabinet in location as directed by the owner.

5. Set static IP, gateway, subnet mask etc. address information furnished by the owner for each requirement component.

6. Configure the DNS name of the server per. owner request.

7. Set the time to be synchronized to a common network time source

B. General: Install system in accordance with NFPA 70 and other applicable codes. Install equipment in accordance with manufacturer's written instructions.

C. Furnish and install all material, devices, components and equipment for a complete operational system.

D. Impedance and Level Matching: Carefully match input and output impedance's and signal levels at signal interfaces. Provide matching networks where required.

E. Set the output tap connection on all new speakers as follows:

1. Indoor corridor and classroom ceiling speakers: 1-watt

2. Machine/Wood/Auto Shop wall mounted speakers: 2-watts

3. Indoor office speakers: ½ watt

4. Outdoor speakers: 5-watts

F. Control Circuit Wiring: Install control circuits in accordance with NFPA 70 and as indicated. Provide number of conductors as recommended by system manufacturer to provide control functions indicated of specified.

G. The contractor shall provide necessary transient protection on the AC power feed, all copper station lines leaving or entering the building, and all central office trunks. All protection shall be as recommended by the equipment supplier and referenced to earth ground.

H. Wiring within Enclosures: Provide adequate length of conductors. Bundle, lace, and train the conductors to terminal points with no excess. Provide and use lacing bars.

I. Provide physical isolation from speaker-microphone, telephone, line-level wiring, and power wiring. Run in separate raceways, or where exposed or in same enclosure, provide 12 inch minimum separation between conductors to speaker-microphones, telephone wiring and adjacent parallel power. Provide physical separation as recommended by equipment manufacturer for other system conductors.

J. Identification of Conductors and Cables: Use color coding of conductors and apply wire and cable marking tape to designate wires and cables so all media are identified in coordination with system wiring diagrams.

K. Weatherproofing: Provide weatherproof enclosures for items to be mounted outdoors or exposed to weather.

L. Ground equipment, conductor, and cable shields to eliminate shock hazard and to minimize to the greatest extent possible, ground loops, common mode returns, noise pickup, cross talk, and other impairments. Provide 5-ohm ground at main equipment location. Measure, record, and report ground resistance.

M. Provide all necessary transient protection on the AC power feed and on all copper station lines leaving or entering the building. Note in system drawings, the type and location of these protection devices as well as all wiring information.

3.2 FIELD QUALITY CONTROL

A. Manufacturer's Field Services: Provide services of a duly factory authorized service representative for this project location to supervise the field assembly and connection of components and the pre-testing, testing, and adjustment of the system.

B. Inspection: Make observations to verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Provide a list of final tap settings of paging speaker line matching transformers.

C. Testing: Rectify deficiencies indicated by tests and completely re-test work affected by such deficiencies at Contractor's expense. Verify by the system test that the total system meets the Specifications and complies with applicable standards.

3.3 CLEANING AND PROTECTION

A. Prior to final acceptance, the contractor shall vacuum and clean all system components and protect them from damage and deterioration. All blank spaces in equipment cabinets will be covered with blank panels. Top and side panels, and all cabinet doors will be installed. All general areas within and around all equipment rack/cabinets in the facility will be swept, vacuumed, and cleaned up. No cabinets will be left unlocked and all cabinet keys will be turned over to the owner or designated owner's representative.

3.4 WARRANTY

A. Provide a manufacturer's five-year warranty of the school communications network equipment against defects in material and workmanship. This warranty will cover all electronic equipment, as well as analog clocks, speakers, and call-in switches. If any defects are found within the warranty period, the defective equipment shall be replaced at no cost (equipment only); a one year warranty shall be provided for labor.

B. A copy of the manufacturer's standard statement of warranty proving all equipment provide for the school communications network is covered with the required five-year warranty shall be provided on the manufacturer's stationary. The standard five-year warranty is an important element in establishing a standard in quality. Manufacturers who circumvent the five-year warranty by offering special "extended warranties" that are not part of their normal published warranty will not be accepted.

C. Contractor shall respond, excluding weekends and holidays, within 24 hours to any warranty service calls. If equipment cannot be repaired within 24 hour of service visit, the contractor shall provide "loaner" equipment to the facility at no charge.

D. Make available a service contract offering continuing factory authorized service of the system after the initial warranty period.

END OF SECTION 275117

SECTION 275313 - WIRELESS MASTER CLOCK SYSTEM

1.0 PART 1 – GENERAL

1.1 WORK INCLUDED

A. Provide all labor, materials, equipment and services required for the installation of a complete and functioning clock system as shown on the drawings and described in this section. The clock system shall include a transmitter, secondary clocks, remote repeater transmitter, and all accessories for complete operation.

B. Expand the existing Visiplex wireless master clock system as called for on the drawings.

C. Provide all required wiring and programming to tie the new master clock system program output relays building new public address system.

1.2 DESCRIPTION OF WORK

A. The system shall synchronize all clocks to each other. The system shall utilize network time protocol technology to provide time correction. The system shall not require hard wiring for time correction. Clocks shall automatically adjust for Daylight Savings Time.

B. Secondary Clocks shall be synchronized to within 1 second 6 times per day, and the system shall have an internal oscillator that maintains plus or minus one second per day between synchronizations. The system shall also include an internal clock reference so that failure of the LAN signal shall not cause the clocks to fail in indicating time.

C. The system shall include a remote repeater transmitter to provide adequate time signals to the clocks in far parts of the building from the master controller.

D. The system shall include a set of programmable contacts on the master controller that is wired to the building public address system for program bell annunciation.

E. Clock locations shall be as indicated, and clocks shall be fully portable, capable of being relocated at any time.

F. The system shall include a remote repeater transmitter to provide adequate time signals to the clocks in far parts of the building from the master controller.

G. The system shall include a set of programmable contacts on the master controller that is wired to the building public address system for program bell annunciation.

H. This section includes minimum requirements for the following:

1. Secondary Clocks

1.3 SUBMITTALS

A. Product Data: Submit complete catalog data for each component, describing physical characteristics and method of installation. Submit brochure showing available colors and finishes of clocks.

B. Quick connect clock wiring connector for 24V and 120V clocks.

C. Operating License: Submit evidence of application for operating license with the FCC prior to installing equipment.

D. Furnish the license, or if the license has not been received, a copy of the application for the license, to the Owner prior to operating the equipment. When license is received, deliver original license to Owner.

1.4 QUALITY ASSURANCE

A. Permits: Obtain operating license for the transmitter from the FCC.

B. Equipment and components furnished shall be of manufacturer's latest model.

C. Transmitter and receiver shall comply with Part 90 of FCC rules, as follows:

1. This device may not cause harmful interference, and this device must accept interference received, including interference that may cause undesired operation.

2. Transmitter frequency shall be governed by FCC Part 90.35.

3. Transmitter output power shall be governed by FCC Part 90.257 (b).

D. Qualifications:

1. Manufacturer: Company specializing in manufacturing commercial time systems with a minimum of 10 continuous years of documented experience.

2. Installer: Company with documented experience in the installation of commercial time systems.

1.5 SEQUENCE OF OPERATION

A. When power is first applied to the transmitter, it checks for and displays the software version, then it checks the position of the switches and stores their position in memory. The transmitter then looks for the LAN provided time using network time protocol. Once the transmitter has received the time, it sets its internal clock to that time. The transmitter then starts to transmit its internal time once every second. The transmitter updates its internal clock every time it receives valid time data from the LAN.

B. Clock Operation:

1. When power is available to the secondary clock: A) Press the red button when the red second hand is at the 12:00 position. At this time the microprocessor will lock in the location of the second hand.

2. After the red second hand has passed over the minute hand (first second hash mark after minute hand), press and release the red button. At this time the microprocessor will lock in the location of the minute hand. The microprocessor then assumes the location of the hour hand. After the red button has been pressed twice, the microprocessor will start searching the channels. It will start at channel No.1 and proceed one by one until it either decodes a valid signal or reaches channel No.16.If no signal is detected the receiver will be shut off and will try again later. If a signal is received, the microprocessor will store the channel number, set the clock to receive the time. For the next minute the clock will beep every time that it receives a valid time signal. If the clock is in a good signal area it will beep once a second. If the clock beeps every few seconds, the clock is in a marginal signal area. Analog clocks can operate in marginal signal areas, but battery life will be about 25 percent shorter.

3. After initial set, the clock will shut off the receiver. On a pre-scheduled basis, the microprocessor will turn the receiver back on and starting with the stored channel, it will again look for a valid time signal. However, the beeper will not operate.

4. If the clock has not decoded a valid time signal for seven days, then it will go back to a double-step mode. Non-signal reception can be caused by low battery voltage. If this occurs, replace the batteries.

2.0 PART 2 – PRODUCTS

2.1 12” WIRELESS BATTERY CLOCK

A. Analog clock, 12-inch diameter, wall mounted, and shall have polycarbonate frame and polycarbonate lens. Face shall be white. Hour and minute hands shall be black. Includes red sweep second hand.

B. Utilizing Network Time Protocol (NTP) time shall be automatically updated from the transmitter at a minimum of 6 times per day.

C. Approximately one watt transmission, 900 MHz frequency hopping or licensed 72 MHz design. Minimum 16 selectable channels.

D. Designed for (2) C Battery power operation for a minimum of 3-years.

E. Include with required batteries.

F. Provide new hanger receptacle at each clock location, and circuit as indicated on drawings. Installation of surface mounted clock shall be smooth and flush with wall.

G. Design Make: Visiplex Model TS4142

2.2 CLOCK QUICK CONNECT

A. Allows 3-wire hand operated quick connect

B. UL 2459 and CSA 182.3 finger-probe safety requirements

C. 120V rated

D. 12-18AWG stranded and solid wire compatible

E. Design Make: IDEAL Model 103 or Approved Equal

3.0 PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that construction is complete in spaces to receive equipment and that rooms are clean and dry.

B. Provide 120 volt electrical outlet within 6 feet of location of transmitter, and that outlet is operational and properly grounded.

3.2 INSTALLATION

A. Provide Cat. 6 cable with RJ-45 plug-in connector from building LAN connection to the transmitter for network time protocol signal.

B. Provide 120Volt 3-wire clock disconnect for each 24V or 120V clock connection. Locate disconnect behind clock.

C. Provide software client and interface cable to allow a Windows PC the ability to program the class change bell controls.

D. Transmitter:

1. Locate transmitter where indicated on drawings, a minimum of 2 to 3 feet above the floor, away from large metal objects such as filing cabinets, lockers or metal framed walls.

2. Attach receiver to transmitter using cable.

3. Connect antenna to transmitter using care not to strip threads.

4. Connect power supply to the transmitter.

5. Set the channel number on the display to correspond to the FCC license.

6. Plug power supply into electrical outlet.

E. Analog clocks: Perform the following operations with each clock:

1. Provide 120 volt branch circuit and mounting receptacle.

2. Set clock to correct time in accordance with manufacturer's instructions.

3. Observe analog clock until valid signals are received and analog clock adjusts itself to correct time.

4. Install the analog clock on the wall in the indicated location, plumb, level and tight against wall. If using 12-1/5 inch clock, attach using clock-lock hanging method and suitable fasteners as approved by clock manufacturer.

F. Provide 2-face back-to-back clocks in the corridors with manufacturer furnished wall bracket.

G. Provide wire guards for all clocks in gymnasiums, locker rooms, team rooms and weight rooms. Secure to wall, using approved tamper-resistant fasteners.

H. Install program bell synchronization on owner direct PC and serial link cable to wireless system. Provide complete initial program bell settings based on owner requirements.

3.3 FCC REGISTRATION

A. Provide all registration filings for the FCC license to operate the new master clock system. Pay all record and filing fees.

3.4 ADJUSTING

A. Prior to final acceptance, inspect each clock, adjust as required, and replace parts which are found defective.

3.5 CLEANING

A. Prior to final acceptance, clean exposed surfaces of clocks, using cleaning methods recommended by clock manufacturer. Remove temporary labels from clock faces. Do not remove labels from backs of clocks.

END OF SECTION 275313

SECTION 281300 - ACCESS CONTROL SYSTEM

1.0 PART 1 – GENERAL

1.1 WORK INCLUDED

A. Provide all equipment, cabling, software, documentation, training, and programming as required for a complete operational system providing the functionality called for. All required component specifications might not be included in the specification however, they must be provided if required for a complete system meeting the functionality described.

B. Expand the existing Avigilon access control system to serve new exterior doors in the new addition.

C. Provide door contacts to monitor status of exits in the addition connected to the existing access control system.

1.2 SCOPE

A. The system shall include but not be limited to the following:

1. Door Controller
2. Proximity/Card Reader
3. Request to Exit Sensor
4. Door Hardware Connections
5. Door Contacts
6. Low-Voltage Wiring

1.3 SUBMITTALS

A. Model numbers of all components furnished on the job.

B. Manufacturer’s catalog data sheets for all components.

C. Complete engineered drawings indicating:

1. Point-to-point wiring diagrams for all devices
2. Location and detection field for motion detectors
3. Power supply sizes and wired loads.
4. Termination details for all devices

5. Single-line system architecture drawings representing the entire system. Indicate make, model and serial no. for all equipment of the diagram.

1.4 QUALITY ASSURANCE

A. Manufacturer: Manufacturers shall have been in business for a minimum of five years and must guarantee that spare parts will be carried for a minimum of 10 years.

B. The installer must be a company specializing in Security/Access Control Systems with a minimum of five years' experience. The installer must have personnel authorized by the system manufacturers. The installer may be a sub-contractor to the electrical contractor.

C. The installer must provide verification that proposed equipment and devices furnished is adequate for the intended purpose. The proposed system must be available to be tested by the owner and engineer in the installer's facility or at an installed site.

1.5 SYSTEM DESCRIPTION

A. The owner will have the capability to add and remove user information located in a central database.

B. The system shall have (1) badging station that will allow the owner to create badges for selected users. The contractor shall be responsible for setting up the initial printing template and printing new badges for the specified staff. The badging station must include a still camera, printer and card stock. The new badges shall be multi-purpose and include proximity access control technology, and a photo ID badge.

C. The owner will be able to create badges that allow access to secured doors using the user database. The badges will have the users image and information fields selected by the owner.

D. The badges will be programmed to allow access to secured doors at specific times as determined by the owner. The access time shall be programmable by individual user or by groups of users.

E. Selected doors will have card readers and electric strikes. Some of the doors with card access and an electric strike will also be released by a pushbutton in the main office. Remaining doors will be normally locked with no access control.

F. Selected doors will include an intercom system connect to the building telephone system. Staff in the high school main office between the hours of 7am-5pm will be able to grant access to the building by interfacing the access control system with their telephone handset or a push button. Any calls not answered before voicemail should be programmed to be forwarded to the administration main office. Staff will have the ability for two way communication with the exterior intercom stations.

G. Outside of normal business hours; e.g. not 7am-5pm all intercom station calls will be forwarded automatically to the administration main office.

H. Upon an abnormal condition on the access control system, abnormal events shall be logged into the database, along with the date and time.

I. The “Request to Exit” sensor on the inside of the exit doors shown will in no way obstruct egress from the building. When the “Request to Exit” sensor detects motion it will unlatch the electric door strike allowing the door to be opened without triggering an alarm flag on the access control system. The proximity reader shall be wired through the “Request to Exit” sensor to control entry to the building from the exterior.

J. Access Control System Functionality

1. The owner will have the capability to add and remove user information located in a central database.

2. The owner will be able to create badges that allow access to secured doors using the user database. The badges will have the users image and information fields selected by the owner.

3. The badges will be programmed to allow access to secured doors at specific times as determined by the owner. The access time shall be programmable by individual user or by groups of users.

4. Selected doors will have card readers and electric strikes. The main door to the building will have card access and an electric strike controlled by a pushbutton in the main office and the security office. Remaining doors will be normally locked with no access control.

5. The system will unlock and lock individual doors or groups of doors, which are equipped with electric strikes based on the owner’s security plan.

6. Card readers shall be interlocked with Intrusion detection system zones to disable an activated zone for an authorized user.

7. The owner will be able to override access settings through any PC terminal equipped with the SMS client or from a manual switch if called for on plans.

2.0 PART 2 – PRODUCTS

2.1 DOOR CONTROLLER

A. Ethernet network connected, POE capable interface board that integrates to the building network controller.

B. Provide a door controller module with the following specifications:

1. Min. single-door capable

2. Two reader ports support separate in/out readers of all types and technologies, including Wiegand, clock and data, magnetic stripe, keypads, LCD and biometrics

3. Inputs and the output relays support assignment to door related functions or to general purpose I/O Inputs

4. Support normally open, normally closed, supervised and non-supervised circuits

5. Output Relays: Form-C contacts: K1, K2: 5A @ 28Vdc Inputs: 4 supervised, End of Line resistors, 1k/1k - Ω,1% 1/4W standard

6. Reader LED support.

7. UL 294 recognized and CE approved.

C. Power Requirements: PoE Power Input 12.95W, compliant to IEEE 802.3af or 12V DC ±10% 900 mA

D. Design Make: Avigilon AC-MER-CONT-LP1502 or Approved Equal

2.2 PROXIMITY CARD READER

A. Indoor/Outdoor sealed weatherized polycarbonate enclosure designed to withstand harsh environments, providing reliable performance and a high degree of vandal resistance. -22° to 150° F (-30° to 65° C) temperature range.

B. Accepts 5 to 16 volts, meeting most voltage requirements.

C. Designed to mount onto a junction box included with each reader. The junction box is attached to an appropriate surface location utilizing four holes.

D. When a proximity card is presented to the reader, the red LED flashes green and the beeper sounds.

E. 5” read range, 125 kHz signal

F. Design Make: HID Signo 40 or Approved Equal

2.3 REQUEST TO EXIT SENSOR

A. PIR technology

B. 12 or 24 VAC, 12 or 24 VDC, 26 mA @ 12 VDC

C. Relay Latch Time Adjustable to 60 seconds

D. Light Grey High impact ABS plastic enclosure

E. Adjustable X – Y pick-up window

F. Wall or ceiling mountable

G. Interfaces door contact, card reader, and door strike

H. Design Make: Bosch DS160 or Approved Equal

2.4 DOOR HARDWARE CONNECTIONS

A. Electric Latch Retraction

1. Provide 120VAC branch circuit connection to the dedicated power supply furnished by others. Provide low voltage wiring from power supply relay output to latch retraction hardware. Route wiring through door frame and power transfer hinge. Coordinate low voltage wiring size with voltage drop chart furnished with electric latch retraction. Min, size shall be 16 AWG stranded copper.

2. Manual push plate egress hardware with internal electrically actuated latch retraction. UL listed for Panic Exit or Fire Exit Hardware, and are tested in accordance to ANSI A156.3, 1994, Grade I.

3. Available for doors 3-feet to 4-feet wide and compatible with rim, mortise and vertical rod devices.

4. Hex key dogging standard

5. A control station operator can flip a switch to retract the latch bolt and immediately change an exit only or latched door to push-pull operation. A powerful, continuous duty solenoid retracts the latch bolt for momentary unlocking, or for extended periods of time, in lieu of manual dogging.

6. Operates on 24VDC power, Current Inrush (300 milliseconds) 16 amperes. Holding Current 0.3 amps Supplied with 3-foor cable at the hinge side of door. Provide power supply to drive door hardware device.

7. Stainless steel housing w/ anodized aluminum finish

8. Provide w/ power transfer protector cable for retrofit applications.

9. Provide matching device trim handle hardware on opposite side of door.

10. Design Make: Dorma, Assa Abloy

2.5 DOOR CONTACTS

A. Button type magnetic contact:

1. 1” diameter magnetic door contacts. Magnet installs in door, contact installs in door frame.

2. Provide single pole, double throw contact with 1’ long #22 AWG leads brought out.

3. Maximum ½” gap.

4. Provide contact that will not affect the fire integrity of U.L. listed fire rated doors.

5. Design Make: Day Automation DAY78G/ST-AD

B. Surface mount magnetic contact:

1. Nominal 2” long x ½” wide x ½” deep.

2. Magnet installs surface mounted on door. Contact installs surface mounted on door frame.

3. Provide single pole, double throw contact with 1’ long, #22 AWG leads brought out.

4. Maximum 1” gap.

5. Design Make: Day Automation DAY400G/ST-AD

2.6 LOW-VOLTAGE WIRING

A. The number of pair per. jacket shall be as required by the system installer.

B. The quantity of shielded or unshielded pair shall be determined by the system manufacturer.

C. Control Cable shall be ASTM tinned copper, 18 AWG (7x26 stranded), twisted pairs, 20 strand shielded drain wire unless recommend otherwise by the system manufacturer.

D. 24Volt power wiring shall be minimum 14 AWG or larger size as indicted on drawings.

E. 300-volt insulation.

F. Cable shall be UL listed NEC type CMP, constructed in accordance with UL 444.

G. Cable shall be fully functional from -10°C to 60°C.

H. Individually colored conductors.

I. Design Make: West Penn/CDT or Approved equal

3.0 PART 3 – EXECUTION

3.1 SYSTEM PROGRAMMING

A. The system installer shall meet with the owner as many times as necessary to finalize system programming. The installer shall review the owner’s security plans and policies and make programming decisions based on that plan.

B. The system installer shall provide a word document that describes the complete operation of the system as decided on during the programming meeting(s). The owner will sign off on the sequence of operation prior to the system programming commencing.

C. The installer shall make changes to the initial system programming for up to 120 days after the initial installation at no additional cost.

3.2 GENERAL INSTALLATION

A. Installation of the SMS shall include the appropriate equipment and shall be performed by a factory-trained Installer. The installation shall be completed to meet the requirements of this specification and the project drawings. The installation shall include the following:

1. Site planning and system configuration of field hardware.

2. Complete hardware setup of all system Workstations, servers and peripherals.

3. Complete configuration of all system Workstations, peripherals and installation of field hardware.

4. Setup of specific network software and hardware configuration requirements.

5. Badge Design and Screen Format installation and verification.

6. Complete system diagnostics verification.

7. Complete system operation verification.

8. Problem reporting and tracking.

9. Project specific installation log.

10. Completion of specific customer acceptance test plans.

11. Formal turnover of the specific project installation documentation to the owner and his Maintenance Service Organization.

B. Coordinate installation of Access control hardware with electric locks provided by the General Contractor

C. Comply with manufacturer's instructions and recommendations for installation of product in the applications indicated. Anchor products securely in place, accurately located and aligned with other work.

D. The Contractor is responsible to remedy defects due to faulty workmanship and materials that appear within one year from the date of acceptance in accordance with the General Conditions, unless Specifications specify a different duration.

3.3 NETWORK CONTROLLERS AND DOOR CONTROLLERS AND POWER SUPPLES

A. Provide (2)-#12, (1)-#12EG in ¾" EMT conduit 120V circuit from 20A/1P circuit breaker for input power. Label panel and circuit breaker designation on outside cover of enclosure.

B. Install in locations shown on plans or centralized Communication Equipment Room approved by the owner.

C. Locate door controllers adjacent to the buildings Network Controller where possible.

D. For reader locations that exceed the maximum distance, locate the door controller in a closer Communication Equipment Room or mechanical space.

E. Provide all Network Controllers and Door Controllers at working height in a hinged lockable NEMA 1 enclosure. Label enclosure “ACCESS CONTROL”.

F. NEMA 1 Enclosure Requirements:

1. Minimum Size: Accommodates up to (4) door controllers.

2. Include required fusible or circuit breaker protected 120VAC to 12VDC power supply.

3. 2-hour lead-acid battery backup supply for operation.

4. Insulated barrier strips for terminating all I/O and power wiring.

5. Plastic wire finger cable management channels around perimeter

6. Paper printed wiring diagram for all controllers in plastic sleeve on cover

7. Wire labels to each door/reader designating the location.

8. Label for the data port and CER on all Ethernet cables

3.4 DOOR HARDWARE

A. Coordinate entire electrified hardware installation with other trades furnishing any electrically operated hardware components and door contacts. The contractor shall walk entire project and review door hardware on all doors scheduled to receive new door strikes. Order electric door strike to fit each individual door based on those doors specific latch mounting requirements.

B. Route low-voltage control wiring and make connections through electric power transfer hinges where provided. Where unable to route as above provide flexible concentric stainless-steel whip, for wiring protection, to electric latch retraction hardware or to bring power from door frame to strike.

C. Electrical contractor to provide all wiring and electrical connections to door strikes, route wiring concealed through hollow metal and aluminum storefront door frames.

D. For installations at existing doors, remove existing latch and install new door strike and modify and drill door mullion and frame as required for mounting. Electrical contractor to provide all wiring and electrical connections to door strike, fish door frame or provide surface raceway on secure side where unable to fish frame.

E. Provide 120VAC branch circuit wiring to door hardware power supply(s). Provide low voltage wiring from power supply to door hardware. Coordinate low voltage wiring size with voltage drop chart furnished with electric latch retraction. Min, size shall be 16 AWG stranded copper.

3.5 MAGNETIC DOOR CONTACTS

A. Install magnetic contacts in locations shown on plans.

B. Provide conduit or surface metal raceway from the accessible ceiling space to the door contact. Install conduit concealed wherever possible.

C. Coordinate work with general contractor

D. Provide button type where possible or surface type where required.

3.6 WIRING, CONDUIT AND CABLE

A. All wiring (high voltage, 50 volts and greater) and conduit is to be installed in accordance with local and national electrical codes.

B. All wiring less than 50 volts shall to be considered low-voltage.

C. All low voltage cable is to be run in conduit in any non-accessible concealed space and up to 10 ft. above floor level within mechanical rooms. Wiring within accessible unfinished areas (ceilings, crawl spaces) may be run exposed with proper support with bridle rings. Bridle rings shall be installed a minimum of 4 ft. on center.

D. Wiring shall be run parallel and perpendicular to building lines in a neat and workmanlike manner and bundled with nylon tie wraps.

E. Conduit sleeves shall be run through any concrete or block walls for low voltage cable to be run through such walls.

F. All low voltage cable shall be run separate from high voltage cable. All microprocessor communications cable shall be run separate from any low or high voltage cable.

G. Wires shall be installed a minimum of three (3) inches from hot water, steam, or condensate piping.

H. A true earth ground shall be available in the building. Ground shall be run from the source electrical panel ground to each controller.

3.7 SYSTEM ACCEPTANCE TEST

A. The contractor will schedule a system acceptance test with the engineer and the owner.

B. The system will not be accepted for operational use and final payment will not be authorized until the owner determines that the system is deemed acceptable.

C. A phased acceptance test and performance demonstration program shall be developed and documented by the Contractor. These requirements shall apply to all system components and software, including, but not limited to all system computers, field panels, card reader devices, Photo Imaging system peripherals, and equipment and interface capability. The Contractor shall perform the tests and document the results under the supervision and witnessing of the Systems Engineer. Operational scenarios shall be developed and used by the Contractor to simulate the actual use of the system in the normal environment of the Owner's facility. The Owner reserves the right to modify the Contractor's plan or develop new operational test and evaluation procedures to effectively document system operations.

3.8 SYSTEM TRAINING

A. Provide on-site by a representative of the access control system manufacturer. The trainer shall be on site for 8 hours. Training shall take place before the system is operational. A detailed description of the training material shall be included in the submittal package. All training courses shall enable the attendees to be capable of all normal system operations within their respective positions.

B. System Administrators shall receive a course detailing the system functions and operations. Course shall offer configuration training on all aspects of the system including data import-export, reports, cardholder management, system workstations, peripherals and field hardware.

C. Photo Imaging Users shall receive a course detailing the functions and operations of all aspects of credential production, image capture, cardholder record management, reports and Workstation peripherals which are part of the Photo Imaging process.

D. Video Surveillance users shall be provided with a course that details recording, playback, archiving features of the software package and troubleshooting of the CCTV cameras and recording equipment.

E. Alarm Monitoring Users shall receive a course detailing the operation of all aspects of alarm monitoring functions, reports, error messages, alarm handling, output relay control and general overview of field hardware.

3.9 SYSTEM DOCUMENTATION

A. Complete documentation shall be provided with the system. The documentation shall completely describe all operations, each program, data sets and the hardware and peripherals. All updates, addendum and adjustments to the documentation shall be provided at no additional charge, in the same quantities as originally required.

B. System Administrator Manual - Overview and step by step guide and instructions detailing all System Administrator functions.

C. User Manual - Step by step guide and instructions detailing all system user functions and responsibilities.

D. Photo Imaging User's Manual - Step by step guide and instructions detailing all image capture, badge creation, cardholder modification and all Photo Imaging user functions and responsibilities.

E. Alarm Monitoring Manual - Step by step guide and instructions detailing all alarm monitoring system user functions and responsibilities.

F. Technical Maintenance Manual - Shall be a comprehensive and detailed document providing all maintenance action, system testing schedules, troubleshooting flowcharts, functional system layout and block diagrams and schematic diagrams of all system wiring.

3.10 WARRANTY

A. Provide one year of software assurance and maintenance upgrades on the Access Control System software added in the project.

B. The Contractor shall warrant all labor, workmanship and materials for a period of One-year from the date of final acceptance. Should a failure occur within the first year to the access control system, the Contractor must provide all labor and materials necessary to restore the system to a complete operating condition, at no cost to the owner.

END OF SECTION 281300

SECTION 282319 - HIGH DEFINITION IP VIDEO SURVEILLANCE

1.0 PART 1 – GENERAL

1.1 WORK INCLUDED

A. Provide all labor, materials, tools, licensing, and equipment required for the complete installation of work called for in the Contract Documents.

1.2 DESCRIPTION OF WORK

A. Provide all labor, materials, equipment, licensing, engineering and service necessary to provide a complete and operating IP CCTV Camera System as shown on the drawings and described in the specifications.

B. Expand the existing Avigilon CCTV camera system to the new additional as shown on the drawings. Provide horizontal cabling to each camera as described in Specification 271000.

C. The following system components are specified in this section

1. IP Camera (Types A & B)

1.3 SYSTEM DESCRIPTION

A. The network video recorder allows the recording, live viewing, and playback of recorded video for periods of up to one month without the need for external storage. NVR performs all viewing, playback, and video storage functions simultaneously.

B. A large formal LED TV shall be wall mounted in the main office to provide viewing of client selected cameras over the network. A PC shall be provided with client software to allow viewing of client selected video feeds. These camera views shall primary be selected to allow access into the building and supervise main points of entry and pickup.

C. Camera Setup Standards:

1. IP Address by provided by owner IT representative

2. Camera Standard: 172.16.xx.zz (xx = Building #; zz = Camera 1, 2, 3….)

3. Subnet Mask: 255.255.252.0

4. Gateway: 172.16.0.1

D. NVR recorders are rack-mountable boxes equipped with external IP encoders Video is displayed on a standard monitor, and configuration is performed through a standard mouse and keyboard interface.

E. NVR is configured with control software and can record video continuously, only during alarm events, or only while activity is present. Each camera can record in different modes and on different schedules, or they can be configured the same.

F. Control software allows for search and retrieval of video. User-defined parameters allow searches based on the time and date the video was captured, whether alarm or motion events occurred, and which camera captured the video. The software also permits full video storage management, hardware control, alarm configuration, and export of video and individual frames.

G. System shall have the ability to use remote viewing software with the ability of viewing live or recorded video over standard network or modem connections. This software shall be available at no cost to the user and shall be downloadable using standard internet connections.

H. Video Surveillance at the Buildings

1. CCTV Camera and Enclosure systems types are identified on the drawings. Refer to this section of the specifications for system descriptions.

2. Surveillance cameras will be located at selected entrance doors, corridors and rooms inside the building as indicated on the plans.

3. Surveillance cameras will be located on the building exteriors to monitor selected parking lots, entrances and secluded areas.

4. PAN-TILT-ZOOM cameras shall be controllable via from the NVR headend or any remote Ethernet workstation with the NVR monitoring and control software.

5. Cameras will be field selectable for activation on motion within the cameras viewing range or to be permanently on.

6. All cameras that are activated shall be recording digital video to the server. The server will automatically save all video and overwrite hard disk media per. custom client settings.

7. In the event of a NVR or network failure video shall automatically save to SD cards installed locally in equipped cameras.

8. The owner will be able to view camera output on monitors in the Main Office of each school and any networked PC running the client software.

9. The output to the monitors may be configured for full or split screen or for random scan of all cameras. In the case where a camera is set to record on motion it will automatically go to full screen on a selected monitor(s).

10. The video will be viewable in on any PC equipped with the client software.

1.4 CODES AND STANDARDS

A. Design and operation of the Network based CCTV System shall conform to the following referenced codes, regulations and standards as applicable:

1. National Electrical Code (NEC)

2. UL 294 Access Control Systems

3. UL 1076 Line Supervision

4. FCC Rules and Regulations

5. Part 15, Radio Frequency Devices

6. National Electrical Manufacturers Association (NEMA)

7. Applicable Federal, State and Local laws, regulations, codes

1.5 QUALITY ASSURANCE

A. Manufacturer: Manufacturers shall have been in business for a minimum of five years and must guarantee that spare parts will be carried for a minimum of 5 years.

B. The installer must be a company specializing in CCTV Systems with a minimum of five years' experience. The installer must have personnel authorized by the system manufacturers. The installer may be a sub-contractor to the electrical contractor.

C. If the installer is a sub-contractor, the wiring and physical equipment installation may be done by the electrical contractor, under the supervision of the qualified sub-contractor. All system programming, configuration, testing and commissioning must be done by the qualified installer's manufacturer certified personnel.

1.6 SUBMITTALS

A. Contractor shall submit on all products listed in this specification section, this shall include the following:

1. Model numbers of all components furnished on the job

2. Manufacturer's catalog data sheets for all components

B. Complete engineered drawings indicating:

1. Point-to-point wiring diagrams for all devices

2. Termination details for all devices

3. Single-line system schematic representing the entire system.

2.0 PART 2 – PRODUCTS

2.1 IP CAMERAS

A. Interior Camera:

1. Image Sensor: Progressive scan RGB CMOS 1/1.8"

2. Lens: Varifocal 4.9 - 8 mm, 52° - 92° view, f1.2

3. Minimum illumination:

   a. Color: 0.055 lux, f1.2

   b. Black/White: 0.028 lux, f1.2

4. Shutter time: 1/8196 sec to 1/7 sec

5. Video Compression: H.264 Baseline and Main Profile (MPEG-4 Part 10/AVC) Motion JPEG

6. Up to 6 Megapixel Resolution (3200 x 1800)

7. Video Streaming: Multiple, individually configurable streams in H.264 and Motion JPEG, Controllable frame rate and bandwidth, VBR/CBR H.264

8. Multi-view Streaming: When streaming 4 view areas and 1 overview in VGA resolution, the frame rate is 20 frame per second (fps) per stream (3 Megapixel capture mode)

9. Image Settings: Compression, color, brightness, sharpness, contrast, white balance, exposure control, exposure zones, backlight compensation, fine tuning of behavior at low light, wide dynamic range – dynamic contrast

10. Auto Back Focus

11. Security Access Password protected, IP address filtering, HTTPS encryption, IEEE 802.1X network access control, Digest authentication, User access log

12. Supported Protocols: IPv4/v6, HTTP, HTTPSc, SSL/TLSc, QoS Layer 3 DiffServ, FTP, CIFS/SMB, SMTP, Bonjour, UPnP, SNMPv1/v2c/v3 (MIB-II), DNS, DynDNS, NTP, RTSP, RTP, TCP, UDP, IGMP, RTCP, ICMP, DHCP, ARP, SOCKS

13. Video Setup Jack

14. Power over Ethernet (IEEE 802.3af)

15. Edge Storage: SD/SDHC/SDXC slot supporting memory card up to 64GB

16. Provide camera with 64GB memory card.

17. Up to 2 Simultaneous Video Streams

18. Internal HTML web server for configuration and viewing capable

19. Service Connector External 3-connector, 2.5 mm provides NTSC/PAL video output.

20. Die-cast aluminum upper shroud camera housing for indoor surface mounting. Conduit knockouts on top and sides for wiring access. Provide recessed flange upper shroud for mounted to accessible ceilings.

21. Operating Conditions (Indoor): Suitable for operation from 32°F to 122°F, humidity 15-85% (non-condensing).

22. Lower smoked dome 360º Horizontal x 30º Vertical capable viewing.

23. Provide vandal resistant model for all cameras.

24. Design Make: Avigilon 3.0C-H6SL-D1-IR or Approved equal

B. Exterior Camera:

1. Image Sensor (Quantity of 3 per camera): Progressive scan RGB CMOS 1/2.5”

2. Lens: Varifocal 3-9 mm, 84° - 30° view, f1.2

3. Provide with packaged Infrared Illumination.

4. Minimum illumination:

a. Color: 0.02 lux, f1.8

b. Black/White: 0.04 lux, f1.8

5. Shutter time: 1/8000 sec to 1/8 sec

6. Video Compression: H.264 Baseline and Main Profile (MPEG-4 Part 10/AVC) Motion JPEG

7. 8 Megapixel Resolution per image sensor (11520 x 2160)

8. Video Streaming: Multiple, individually configurable streams in H.264 and Motion JPEG, Controllable frame rate and bandwidth, VBR/CBR H.264

9. Multi-view Streaming: When streaming 4 view areas and 1 overview in VGA resolution, the frame rate is 12 frame per second (fps) per stream (5 Megapixel capture mode)

10. Image Settings: Compression, color, brightness, sharpness, contrast, white balance, exposure control, exposure zones, backlight compensation, fine tuning of behavior at low light, wide dynamic range – dynamic contrast

11. Auto Back Focus

12. Security Access Password protected, IP address filtering, HTTPS encryption, IEEE 802.1X network access control, Digest authentication, User access log

13. Supported Protocols: IPv4/v6, HTTP, HTTPSc, SSL/TLSc, QoS Layer 3 DiffServ, FTP, CIFS/SMB, SMTP, Bonjour, UPnP, SNMPv1/v2c/v3 (MIB-II), DNS, DynDNS, NTP, RTSP, RTP, TCP, UDP, IGMP, RTCP, ICMP, DHCP, ARP, SOCKS

14. Video Setup Jack

15. Power over Ethernet (IEEE 802.3af)

16. Edge Storage: SD/SDHC/SDXC slot supporting memory card up to 64GB

17. Provide camera with 64GB memory card.

18. Up to 2 Simultaneous Video Streams

19. Internal HTML web server for configuration and viewing capable

20. Service Connector External 3-connector, 2.5 mm provides NTSC/PAL video output.

21. Provide vandal resistant model for all cameras. Refer to floor plans and camera enclosures section of this specification for additional information.

22. Die-cast aluminum upper shroud camera housing for outdoor surface mounting. Conduit knockouts on top and sides for wiring access.

23. Operating Conditions (Outdoor): All outdoor cameras shall come with preinstalled POE heater, fan, and integrated dehumidifying membrane suitable for operation from -40°F to 131°F, humidity 15-100% (condensing).

24. Lower smoked dome 360º Horizontal x 30º Vertical capable viewing.

25. Provide with Pendant Wall Mount arm bracket

26. Design Make: Avigilon 12C-H5A-4MH or Approved Equal

2.2 VIDEO CABLING

A. Refer to section 271000 - Horizontal and Backbone Communication Cabling for 100 Ohm UTP cable (Category 6 cable) and termination requirements.

3.0 PART 3 – EXECUTION

3.1 GENERAL INSTALLATION

A. Prior to installing any equipment the contractor shall walk the buildings with the engineer and District personnel to determine acceptable pathways, installation methods and final locations of equipment. Installation methods that are not approved will be subject to removal and reinstallation at no additional cost to the owner.

B. Installation of the IP based CCTV system shall include the appropriate equipment and shall be performed by a factory-trained Installer. The installation shall be completed to meet the requirements of this specification and the project drawings. The installation shall include the following:

1. Site planning and system configuration of field hardware.

2. Complete hardware setup of all system Workstations and peripherals.

3. Setup of specific network software configuration requirements.

4. Complete system diagnostics verification.

5. Complete system operation verification.

C. Comply with manufacturer's instructions and recommendations for installation of product in the applications indicated. Anchor products securely in place, accurately located and aligned with other work.

D. The Contractor is responsible to remedy defects due to faulty workmanship and materials that appear within one year from the date of acceptance in accordance with the General Conditions, unless Specifications specify a different duration.

3.2 CAMERAS

A. Provide cat. 6 cable for IP connection from each camera back to CER. Provide PoE extender in-line for all cable runs over 300-feet. Use of PoE extenders shall be approved by engineer in advance.

B. The final aiming, focusing and lens selection of cameras shall be done by the system vendor's qualified representative in conjunction with the engineer.

C. Aim and focus cameras initially and test the system. Re-aim and focus the cameras as necessary to the owner's satisfaction.

D. Coordinate all final camera locations in interior and exterior locations prior to rough-in with the owner.

E. Field verify required mounting brackets for exterior cameras. The exact mounting hardware will be determined by the required field of view.

3.3 WIRING, RACEWAYS AND CABLE

A. Provide a category 6 patch cable from NVR to the Ethernet Switch.

B. All power wiring shall be installed in raceway and is to be installed in accordance with Local and National Electrical Codes.

C. All video wiring within accessible unfinished areas (ceilings, mechanical spaces, and crawl spaces) may be run exposed with proper support with bridle rings. Bridle rings shall be installed a minimum of 4 ft. on center.

D. Provide V700 surface metal raceway and associated fittings in finished areas across non-accessible masonry walls. All surface raceway in finished areas shall be painted to match adjacent surface finish.

E. Wiring shall be run parallel and perpendicular to building lines in a neat and workmanlike manner and bundled with nylon tie wraps.

F. Provide conduit sleeves, with applicable fire-proofing through any concrete or block walls for low voltage cable routing.

G. All low voltage cable shall be run in separate raceways from public address or 120V or higher branch circuiting.

H. All exposed wiring shall be installed a minimum of three (3) inches from hot water, steam, or condensate piping.

I. Raceways containing video cabling to exterior cameras shall be concealed inside of buildings.

3.4 SYSTEM ACCEPTANCE TEST

A. Provide demonstration, in the presents of the owners representatives, showing the complete operation of entire system functionality.

B. Make all changes required from the punch list generated during initial testing/demonstration. Schedule a second acceptance test/ demonstration with the District. If additional testing is required after the second test/ demonstration, the contractor will reimburse the district and their representatives for their time at a rate of 2 times their expenditure for their actions.

C. Upon final completion of the punch list as determined by the District, the entire systems and associated equipment furnished by the contractor will be subjected to a thirty (30) consecutive day operational test to determine the reliability of the equipment. If the results of this operational test are acceptable to the district the warranty period will begin.

D. If any part of the system fails during the (30) thirty consecutive days, the contractor will resolve the problems and start the test again beginning with day one. The contractor will be given two (2) opportunities to successfully complete the 30 consecutive day operational testing period.

E. The performance of the entire system will not be less than 100% during the operational 30 consecutive day test period. 100% performance is defined as no trouble reports attributed to the system or contractor's actions during the acceptance period. The district may add other requirements to the Standard of Performance, as it deems necessary.

F. The system will not be accepted for operational use and final payment will not be authorized until the district determines that the entire system is deemed acceptable.

G. In the event that the entire system (including any special or optional features ordered and installed) have not achieved the Standard of Performance within the two 30 (thirty) day periods, the District may terminate the tests, at its option, and require the contractor to provide a complete system replacement of its choice at no additional cost to the district.

H. In this case the reference to "system" or "entire system" means all equipment at all buildings are complete and fully functional. Final acceptance will not be done one building at a time.

3.5 SYSTEM DOCUMENTATION

A. Complete documentation shall be provided with the system. The documentation shall completely describe all operations, each program, data sets and the hardware and peripherals. All updates, addendum and adjustments to the documentation shall be provided at no additional charge, in the same quantities as originally required.

B. System Administrator Manual - Overview and step by step guide and instructions detailing all System Administrator responsibility and authority.

C. User Manual - Step by step guide and instructions detailing all system user functions and responsibilities.

D. Technical Maintenance Manual - Shall be a comprehensive and detailed document providing all maintenance action, system testing schedules, troubleshooting flowcharts, functional system layout and block diagrams and schematic diagrams of all system wiring.

3.6 SYSTEM TRAINING

A. Provide at least two owner selected representatives with a (2) separate four hour hands on training session that details recording, playback, archiving features of the software package and troubleshooting of the CCTV cameras and recording equipment. All attendees shall be recorded on a sign-in sheet with the data. The sign-in sheet shall be included with the final O&M manuals. Training session shall occur on separate days.

B. Provide an additional 2-hour follow up training course after the accepted thirty consecutive day acceptance period.

C. Notify the owners representatives of when the training course are scheduled and included a copy of the attendee sign in sheet in the O&M Manuals.

3.7 WARRANTY

A. The Contractor shall warrant all labor, workmanship and materials for a period of one (1) year from the date of final acceptance. Should a failure occur within the first year to the access control system, the Contractor shall provide all labor and materials necessary to restore the system to a complete operating condition, at no cost to the Owner.

B. The contractor affix a card with their Company name and phone number to the NVR.

END OF SECTION 282319

SECTION 283110 - FIRE DETECTION AND ALARM SYSTEM WITH VOICE EVACUATION

1.0 PART 1 – GENERAL

1.1 WORK INCLUDED

A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.

B. Provide installed spare devices as listed in this section to be turned over at the end of the project to the owner.

C. Labeling of addressable devices to be approved by owner and each addressable device shall be provided with a custom label designation (e.g. M1-44) in black text on an adhesive backed plastic label. Labeling on device to be by Electrical Contractor (EC).

1.2 DESCRIPTION OF WORK

A. Expand the existing Potter IPA-4000 fire alarm voice evacuation system to the new addition and renovated spaces and provide modules for new HVAC units.

B. This section includes minimum requirements for the following:

1. Addressable Input Modules (Monitor)
2. Addressable Output Modules (Control)
3. Manual Pull Stations
4. Smoke Detectors
5. Heat Detectors
6. Large Venue Speakers
7. Audible Notification Appliances (Speakers)
8. Audible/Visual Notification Appliances (Speaker/Strobes)
9. Visual Notification Appliances
10. Magnetic Door Hold Opens
11. Cabling

1.3 QUALITY ASSURANCE

A. All raceways shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

B. The fire alarm system contractor shall be a NYS licensed fire alarm installer.

C. Materials specified herein shall comply with the applicable requirements of

1. The following Articles of the National Electric Code (NFPA 70)

a. Article 760 - Fire Alarm Systems

2. The following National Fire Protection Agency (NFPA) standards:

a. NFPA 72 - National Fire Alarm Code

b. NFPA 101 - Life Safety Code

3. Latest adopted edition of the NYS Building Code

4. Latest adopted edition of the NYS Mechanical Code

5. The following U.L. Standards:

a. UL 864/UOJZ,APOU - Control Units for Fire Protective Signaling Systems

b. UL 268 - Smoke Detectors for Fire Protective Signaling Systems

c. UL 268A - Smoke Detectors for Duct Applications

d. UL 521 - Heat Detectors for Fire Protective Signaling Systems

e. UL 228 - Door Holders for Fire Protective Signaling Systems

f. UL 464 - Audible Signaling Appliances

g. UL 1638 - Visual Signaling Appliances

h. UL 38 - Manually Activated Signaling Boxes

i. UL 346 - Waterflow Indicators for Fire Protective Signaling Systems

j. UL 1481 - Power Supplies for Fire Protective Signaling Systems

1.4 SUBMITTALS

A. Provide standard product data for all equipment indicating the type, size, rating, style, catalog number, and listing of the equipment and quantities.

B. Provide calculations for sizing all batteries and power supplies. The calculations shall include a listing of current used by all current consuming devices in both the standby and alarm mode on each circuit. Provide voltage drop calculations indicating acceptable minimum end of line voltage for the specific equipment used.

C. Provide a complete riser diagram indicating types of devices, number of initiation and signal loop circuits, class of wiring system, and type of wiring and listing for indoor and outdoor use. Include candela and dB level for all notification devices on riser.

D. Architectural floor plans and drawings showing system details including specific location of FACP, all system devices, device ID label addresses, raceway sizes, raceways routings cabling in raceways, end of line devices, power supplies and any other system components.

E. Provide a complete riser diagram indicating all devices with addresses, number of initiation and signal loop circuits, class of wiring system, and type of wiring.

1.5 SYSTEM DESCRIPTION

A. Point addressable network capable fire alarm system with manual and automatic initiation devices. The system shall allow individual alarm and real-time status device level communication back to all other fire alarm panel(s).

B. System shall be supervised to continuously monitor the integrity of the circuit conductors and power supplies.

C. Performance of the fire alarm system circuits shall be in accordance with Class B operation for Initiating Device Circuits (IDC) and Class B operation for Notification Appliance Circuits (NAC's).

D. The fire alarm control panel shall permit on-site programming to accommodate facility expansions, renovations, or fire alarm system modifications. All memory shall be non-volatile.

E. The control panel shall have 24 VDC output power supplies for notification appliance circuits and sprinkler system activation bell. System shall be capable of adding additional power supplies as required to power all notification appliances.

F. Summary Reports:

1. The Fire Alarm Control Panel shall be capable of displaying and printing summary reports. The summary reports shall include:

a. A list of all alarm points not in their normal state.

b. A list of all points in the system, including their current status.

c. A list of data for all control by event programs.

d. A list of data for all time initiated programs.

G. Alarm Priority:

1. Alarms shall be processed at three levels of priority:

a. Fire alarms shall have the highest priority.

b. Other alarms that require interaction by the attendant shall have the second level of priority.

c. Monitored points which do not require interaction by the attendant shall be the lowest level of priority.

H. System Access:

1. Access to the system shall be controlled by at least three levels of security to prevent programming modifications by unauthorized personnel.

a. The lowest level of access, shall permit the attendant to view the system display, print alarms and perform life safety control by event functions. The Attendant has minimal access to the system functions.

b. The mid-level access shall permit the attendant to change user programmable parameters.

c. The highest level of access shall permit the modification of system software. This level shall be accessed only by a qualified representative of the equipment manufacturer.

1.6 SEQUENCE OF OPERATION

A. Upon an abnormal condition on the fire alarm system, the appropriate LED (alarm, supervisory, or trouble) shall flash. The panel audible alarm shall pulse for alarm conditions and sound steadily for trouble or supervisory conditions. All abnormal events shall be logged into the database, along with the date and time.

B. For the purposes of this specification section audible base smoke detectors and listed fire alarm speaker devices are considered audible signal devices.

C. For the purposes of this specification visual strobes or combination speaker/strobes are considered visual devices.

D. Voice Evacuation System:

1. Each listed fire alarm speaker shall be connected back to the network voice evacuation system. It shall be programmed and connected so a single pre-recorded or live message can be transmitted from a fire alarm panel or fire fighter telephone to all connected fire alarm speakers or specific buildings or units where partial alarms are provided as part of the sequence of operation.

2. Each voice amplifier shall be listed with the FACP to provide visual strobe and audible fire alarm notification and voice instruction.

3. Each continuous building audio booster panel(s) shall be connected so they can provide Fire Alarm notification to its individual continuous building.

4. The Fire Alarm System shall have the highest priority and take-over in the event the Mass Notification System is providing audio input.

5. Upon activation of the Voice Evacuation System within every building, during manual notification a “Supervisory Condition” shall be indicated in the FACP of the corresponding building. When the activation is cleared the FACP shall indicate “Normal Condition”.

6. A microphone located in the fire alarm control panel and any indicated remote annunciator panels with microphone shall be capable of manual live audio message broadcast to the voice evacuation system.

E. Operation of any single smoke detector, heat detector, or manual pull station in shall cause the following to happen:

1. Signal a general alarm condition at the fire alarm control panel.

2. Activate the Voice Evacuation System and connected NAC panels to sound all audible and visual alarm signal devices throughout the continuous building in a temporal code or with voice instructions until silenced at the FACP.

3. Display the points in alarm on the LCD display at the fire alarm control panel and at all remote alarm annunciator panels and update the event log. The visual indication shall remain until the alarm condition is reset.

4. Notify the UL listed central station via dial up digital communicator.

5. Operate the fan shut-down relay for the HVAC systems in the same smoke compartment or smoke zone.

6. Operate all smoke dampers in the same smoke compartment or smoke zone. Dampers shall close 30 seconds after their respective fan systems have shut down.

7. Release all doors on magnetic hold opens.

8. Subsequent initiating alarms shall repeat the respective sequence of operations.

F. Operation of any single heat detector in unoccupied spaces (mechanical or storage rooms) or operation of more than one alarm initiating device(s) in any building shall cause the following to happen.

1. Signal a general alarm condition at the fire alarm control panel.

2. Activate the Voice Evacuation System and connected NAC panels to sound all audible and visual alarm signal devices throughout the continuous building in a temporal code or with voice instructions until silenced at the FACP.

3. Display the points in alarm on the LCD display at the fire alarm control panel and at all remote alarm annunciator panels and update the event log. The visual indication shall remain until the alarm condition is reset.

4. Notify the UL listed central station via dial up digital communicator.

5. Release all doors on magnetic hold opens.

6. Subsequent initiating alarms shall repeat the respective sequence of operations.

G. Operation of any carbon monoxide detector shall cause the following to happen:

1. Signal a supervisory signal only at the fire alarm control panel and remote annunciator.

2. All carbon monoxide detectors throughout the building shall provide activation of a distinct carbon monoxide detector audible code within the same continuous floor. Activate all connected carbon monoxide visual notification appliances.

3. Display the points in alarm on the LCD display at the fire alarm control panel and at all remote alarm annunciator panels and update the event log. The visual indication shall remain until the alarm condition is reset.

4. Notify the UL listed central station via dial up digital communicator.

5. Subsequent supervisory alarms shall repeat the respective sequence of operations.

H. Synchronize all visual notification appliances (strobes) in the same field of view as per NFPA 72.

I. The Fire Alarm System wiring and power supplies shall be electrically supervised and report trouble conditions to the fire alarm control panel. Any opens, shorts or grounds on the system wiring shall cause the following to happen

1. Sound a distinct pulsed trouble signal at the fire alarm control panel.

2. Flash the yellow common trouble LED.

3. Display the points in alarm on the LCD display at the fire alarm control panel and at all remote alarm annunciator panels. The visual indication shall remain until the alarm condition is reset.

4. Subsequent trouble alarms shall repeat the respective Sequence of Operation.

J. Alarm Silencing:

1. Pressing the "Alarm Silence" button shall cause all audible and visual notification appliances to be deactivated. A yellow LED located in the fire alarm control panel shall illuminate to indicate the alarm has been silenced.

2.0 PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS/SUPPLIERS AND EQUIPMENT

A. The existing system serving this building is the Potter IPA-4000 series fire alarm control panel. All devices provided as part of this contract shall be compatible with this system.

2.2 NOTIFICATION APPLIANCE CIRCUIT EXTENDER PANELS

A. Shall be compatible with the fire alarm panel and audible and visual notification signal devices.

B. Supervises for power loss, brownout, and batteries, and has power-on and trouble LEDs.

C. Two trip inputs with configurable output correlation.

D. Four independently controlled power-limited output circuits with general alarm operation, available as Class B or Class A. Provides strobe synchronization.

E. Sized to accommodate all devices shown on drawing plus a minimum of 30% spare capacity.

F. Output: 2 Amp per circuit @ 24VDC nominal.

G. Provide with 120VAC power supply, batteries and charger sized to support the system for 24 hours, and then operate all notification appliances for 15 minutes.

H. All equipment mounted in NEMA 1 lockable enclosure.

I. Addressable type when used with addressable notification devices.

J. Design Make: Potter PSN1000 series

2.3 ADDRESSABLE INPUT MODULES (MONITOR)

A. Addressable device used to connect 2 class B analog initiating device circuits.

B. Input circuit wiring requirements

1. Maximum allowable wire resistance - 50 ohms per circuit

2. Maximum allowable wire capacitance - .1uF per circuit

C. Polling and alarm/active status provided by on board red and green LEDs.

D. Design Make: Potter PAD100 Series

2.4 ADDRESSABLE OUTPUT MODULES (CONTROL)

A. Addressable device with a form “C” dry relay contact used to control external appliances such as door closers, fans, dampers etc.

B. Provide a remote LED alarm and key operated test switch for each damper connection. Install remote test switches in visible (below ceiling space) and accessible locations adjacent each damper.

C. Relay contact rating:

1. 24 VDC = 2amps (pilot duty)

2. 120 Vac = .5 amps

D. Polling and alarm/active status provided by on board red and green LEDs.

E. Design Make: Potter PAD100 Series

2.5 MANUAL PULL STATIONS

A. Semi-flush, dual-action type.

B. High impact red housing with contrasting white “Pull for Fire” lettering.

C. Upon activation, handle shall lock in the alarm condition. A key shall be required to reset the manual pull station. Cylinders shall be keyed to match the fire alarm control panel.

D. Provide addressable input module.

E. Design Make: Potter PAD100-PSDA

2.6 SMOKE DETECTORS

A. Detector shall operate on a light scattering principal. The detector shall have a photo-optic chamber with an infrared light emitting diode and a high speed light sensing photo diode. Capable of sensing visible products of combustion.

B. Alarm conditions shall be indicated by a steady red glow from the LED mounted on the sensor.

C. Sensor shall be microprocessor based, with electronic point addressing to indicate to the system which device is in alarm.

D. The sensor shall be continuously monitored to measure any changes in sensitivity due to dirt, smoke or humidity. Any buildup of foreign material shall cause trouble signal at the control panel indicating that maintenance is required.

E. Sensor shall be capable of automatic device mapping and day/night sensitivity adjustment.

F. Sensors shall be twist lock mounted to a separate base provided with screw terminals for field wiring. The detector shall be tamper resistant and shall be removable only with a special tool.

G. Provide auxiliary relays and 24 VDC power for elevator capture or smoke evacuation control where indicated.

H. Design Make: Potter PAD200-PD

2.7 HEAT DETECTORS

A. Self-restoring thermal detector.

B. Rated at 135°F (or as indicated on drawings) fixed temperature. Provide 190°F fixed temperature in boiler rooms, kitchens and where indicated on plans.

C. Design Make: Potter PAD100-HD

2.8 LARGE VENUE SPEAKERS

A. Shall be compatible with the Fire Alarm System and any connected UL listed Mass Notification System.

B. Surface mount speaker w/ adjustable tilt universal bracket.

C. 9” diameter horn, 4.5 lbs, red housing with white text wording “FIRE”

D. Power Output selectable 25/70 Volts: Taps settings 0.9W, 1.8W, 3.8W, 7.5W, 15.0W

E. The horn shall have a dispersion of 70 degrees.

F. Wide frequency range: 400 Hz – 7 kHz, optimized for human voice. Crystal-clear voice and high impact tones.

G. Acoustic Output:

1. 0.9 Watt Tap @ 10-feet - 90dB

2. 1.8 Watt Tap @ 10-feet - 93 dB

3. 3.8 Watt Tap @ 10-feet - 96 dB

H. UL 1480 and ULC S541 listed.

I. Weather-resistant, vandal resistant aluminum construction assures protection against water, humidity and corrosion.

J. Ambient operating temperature range: -31°F to 150°F.

K. Provide wire guards as shown on plans.

L. Design Make: Wheelock STH-15SR or Approved Equivalent

2.9 CEILING MOUNTED AUDIBLE NOTIFICATION APPLIANCES (SPEAKERS)

A. Shall be compatible with the Voice Communications Control Panel.

B. Provide back box and tile bridge for ceiling recessed installations.

C. Operate on a 25 VRMS or 70.7 VRMS.

D. Provide with a line supervisory capacitor.

E. Twisted /shielded wire is required for speaker connections on a standard 25 VRMS or 70.7 VRMS NAC, having a minimum of 3 twists per foot is required for addressable strobe connections.

F. The following taps are available: 0.25W, 0.50W, 1.0W, and 2.0W. At the 1.0W tap, the speaker has minimum UL rated sound pressure level of 84 dBA at 10 feet.

G. The unit shall have a frequency response of 400 to 4,000 Hz for Fire Alarm and 125 to 12kHz for General Signaling.

H. Speaker shall be 4-inch, 8 ohms impedance.

I. White housing with red text reading “FIRE”.

J. Design Make: Potter FASPKR

2.10 CEILING MOUNTED AUDIBLE/VISUAL NOTIFICATION APPLIANCES (SPEAKER/STROBES)

A. Shall be compatible with the Voice Communications Control Panel.

B. Provide back box and tile bridge for ceiling recessed installations.

C. Audible speaker shall have the following characteristics:

1. Operate on a 25 VRMS or 70.7 VRMS.

2. Provide with a line supervisory capacitor.

3. Twisted /shielded wire is required for speaker connections on a standard 25 VRMS or 70.7 VRMS NAC, having a minimum of 3 twists per foot is required for addressable strobe connections.

4. The following taps are available: 0.25W, 0.50W, 1.0W, and 2.0W. At the 1.0W tap, the speaker has minimum UL rated sound pressure level of 84 dBA at 10 feet.

5. The unit shall have a frequency response of 400 to 4,000 Hz for Fire Alarm and 125 to 12kHz for General Signaling.

6. Speaker shall be 4-inch, 8 ohms impedance.

D. Visual strobe shall have the following characteristics:

1. ADA compliant.

2. White light output of 15, 30, or 75 candela.

3. Flash rate from 1 Hz to 3 Hz.

4. Pulse duration of 0.02 seconds.

E. White housing with clear lens and contrasting red “FIRE” lettering on two sides.

F. Design Make: Potter SPKSTR-24CLP

2.11 WALL MOUNTED AUDIBLE/VISUAL NOTIFICATION APPLIANCES (SPEAKER/STROBES)

A. Provide back box for recessed installation.

B. Audible speaker shall have the following characteristics:

1. Shall be compatible with the Voice Communications Control Panel.

2. Operate on a 25 VRMS or 70.7 VRMS.

3. Provide with a line supervisory capacitor.

4. Twisted /shielded wire is required for speaker connections on a standard 25 VRMS or 70.7 VRMS NAC, having a minimum of 3 twists per foot is required for addressable strobe connections.

5. The following taps are available: 0.25W, 0.50W, 1.0W, and 2.0W. At the 1.0W tap, the speaker has minimum UL rated sound pressure level of 84 dBA at 10 feet.

6. The unit shall have a frequency response of 400 to 4,000 Hz for Fire Alarm and 125 to 12kHz for General Signaling.

7. Speaker shall be 4-inch, 8 ohms impedance.

C. Visual strobe shall have the following characteristics:

1. ADA compliant.

2. White light output of 15, 30, or 75 candela.

3. Flash rate from 1 Hz to 3 Hz.

4. Pulse duration of 0.02 seconds.

D. High impact red housing with clear lens and contrasting white “FIRE” lettering.

E. Provide weather resistant model where noted on floor plans.

F. Design Make: Potter SPKSTR-24CLP

2.12 CEILING MOUNTED VISUAL NOTIFICATION APPLIANCES

A. Provide back box and tile bridge for ceiling recessed installations.

B. 24 VDC.

C. Visual strobe shall have the following characteristics:

1. ADA compliant.

2. White light output of 15, 30, or 75 candela.

3. Flash rate from 1 Hz to 3 Hz.

4. Pulse duration of 0.02 seconds.

D. White housing with clear lens and contrasting red “FIRE” lettering on two sides.

E. Design Make: Potter CS

2.13 WALL MOUNTED VISUAL NOTIFICATION APPLIANCES

A. Provide backbox for recessed installations except for installations on existing walls.

B. 24 VDC.

C. Visual strobe shall have the following characteristics

1. ADA compliant.

2. White light output of 15, 75, or 177 candela.

3. Flash rate from 1 Hz to 3 Hz.

4. Pulse duration of 0.02 seconds.

D. High impact red housing with clear lens and contrasting white “FIRE” lettering.

E. Provide weather resistant model where noted on floor plans.

F. Design Make: Potter S-24

2.14 MAGNETIC DOOR HOLDERS

A. Magnetic door holders shall be provided as part of the electrical contract.

B. Provide surface mounted 24VDC or 120 VAC field selectable. Power shall be from separate power supply and not the FACP.

C. Electrical Contractor shall mount and connect all magnetic door holders.

D. 1-gang mountable, 3 5/8” projection depth

E. 316 stainless steel alloy housing with satin aluminum finish

F. Design Make: ASSA ABLOY Rixon 998M or Approved Equal

2.15 CABLING

A. SLC Circuits

1. 16/2 Stranded, Unshielded, FPLP

2. Design Make: West Penn 60991BS or Approved Equivalent

B. NAC, Auxiliary Power, Door Holder Circuits

1. 14/2 Stranded, Unshielded, FPLP

2. Design Make: West Penn 60993BS or Approved Equivalent

C. Speaker Circuits

1. 16/2, Shielded, FPLR

2. Design Make: West Penn 991 or Approved Equivalent

3.0 PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. All installations shall be accomplished in a professional manner by qualified personnel regularly engaged in and experienced in this type of Work. All fire alarm installers shall possess a state license for installation of fire alarm systems where required

2. During installation and testing, and prior to the system being put into service, all manual stations shall be appropriately marked "NOT IN SERVICE" by the Contractor.

3. Provide all 120-volt, 60 cycle AC required to power the system and all remote power supplies.

4. Wiring to all initiation and signal circuits shall be two wire class B. A fault on a circuit loop shall cause a trouble alarm to initiate at the fire alarm control panel.

5. All wiring shall conform to NEC Articles 725 and 760, and to NFPA-72, "National Fire Alarm Code".

6. Detection and initiating equipment shall be listed by UL or approved by FM.

7. Install smoke detectors a minimum of 3 feet away from any air supply or return diffuser.

8. All surface mounted devices shall be mounted on a special box furnished by fire alarm equipment manufacturer. Total assembly shall be secure, smooth contour and have no protrusions.

9. Where detectors are installed on wood or masonry surfaces, attach brackets directly to the surface with tamperproof fasteners. Where detectors are installed on suspended ceilings, provide additional supports in the ceiling, such as channel support system, angle iron or additional runner bars. Fasten the additional supports rigidly to the ceiling runner bar system. Attach bracket to the supports with tamperproof fasteners. Install metal spacers between the bracket and supports so that the ceiling tiles will not be a part of the support system.

10. Mount FACP and all sub panels at working height.

11. Provide additional programming at the FACP for custom LCD messages. All initial programmed messages shall be modified to match the final room/space designation after occupancy has occurred

12. Provide type label adjacent to all programmed LEDs or buttons customized on Fire Alarm Panels. Provide engraved plastic label on each fire alarm panel indicating the building name that will display during annunciation sequences

13. Provide and wire fan shutdown relay contacts in series with starters ahead of all control devices.

14. FACP initiating circuits will be populated leaving at least 20% spare addresses per loop and floor.

15. All FACP or AUXILIARY NAC output circuits shall leave at least 20% spare output power for future expansion

16. Coordinate assignment of ADDRESS LABELS for all reporting points on fire alarm system with the owner.

17. All controlled devices such as smoke dampers, fire dampers, elevator control and door control shall be supervised to within 4’ of the controlled device.

B. Audible/Visible Device Installation:

1. Field verify audible alarm type in existing building and provide to match existing signal type.

2. Visual strobes shall be 75-candela output in all other locations unless otherwise noted.

3. Devices shall be installed at eighty inches (80") minimum above the floor, or six inches (6") below the ceiling, whichever is lower, in accordance with ADA guidelines.

4. Audible devices intended for operation in public spaces shall have a sound level of not less than seventy-five (75) dBA at ten feet (10'), nor more than 110 dBA at the minimum hearing distance from the device.

5. Audible devices intended for operation in private spaces shall have a sound level of not less than forty-five (45) dBA at ten feet (10'), nor more than 110 dBA at the minimum hearing distance from the device.

6. All audible emergency alarm signals shall be at least 15 dBA over the existing sound level within a space or shall exceed the maximum sound level by 5 dBA for at least 60 seconds, whichever is louder. Within areas occupied by persons with hearing impairments, audible emergency alarms must have the intensity and frequency to provide notification of an alarm condition.

7. ALL NAC POWER EXTENDERS and other system power supplies shall be approved by FACP manufacturer, support full monitoring and meet all NFPA requirements. Provide required 120-volt branch circuit for proper system operation

8. ALL VISUAL NOTIFICATION APPLIANCES will be synchronized with all others in a given area where 2 or more devices can be viewed simultaneously

9. Do not exceed 80% loading on any NAC power circuit.

C. Voice Evacuation System

1. Program up to four pre-recorded messages.

2. Configure the fire alarm panel and remote annunciator mounted microphone to allow live message broadcast under alarm conditions. The live voice messages shall over-ride any repeating alarm tones.

3. Provide intelligibility testing of the system as outlined in NFPA 72. Adjust tap values as required to achieve speech intelligibility and volume output of audible notification devices.

D. Wiring:

1. Provide Fire Alarm Terminal Cabinet on each floor and wing of the building. Install adjacent to the NAC panel.

2. Install all wiring in accordance with manufacturer's recommendations and the National Electric Code.

3. All fire alarm voice evacuation speaker appliance and network cabling shall be installed in a continuous, enclosed metallic raceway system. In areas above accessible drop ceilings only, SLC, visual notification appliance, and 24-volt power cabling shall be run free-air and supported by an independent cable hanger system. Cabling in all other areas shall be installed in a continuous, enclosed, metallic raceway system.

4. Do not install voice evacuation speaker cabling in same raceway as SLC, visual notification appliance, or 24-volt power cabling unless approved by system manufacturer.

5. Refer to specification section 260533 – Raceways for the appropriate wiring method for each unique location on this project.

6. Through-wall penetrations shall be sleeved with EMT conduit with bushings and appropriate fire stopping.

7. Paint all junction box covers in the raceway system red.

8. Underground conduit shall be Schedule 40, PVC at twenty-four (24) inches, minimum, below grade. Risers from underground conduits to exterior devices shall be rigid steel. Underground conduits shall be 3/4 inch trade size, minimum. A separate ground wire shall be pulled and properly terminated when PVC conduit is used.

9. Wire and cable shall be #14 AWG size, solid copper, THHN/TWN for horns, manual stations, smoke or heat detectors, waterflow switches, valve supervisory switches and other initiating and indicating devices. Communication loop wiring shall be shielded or accordance with the Manufacturer's recommendations.

10. Wiring shall be continuous from device to device. Splicing shall be accomplished by use of terminal blocks in locked cabinets keyed alike with the fire alarm control unit, or junction boxes. No connections or splices shall be made underground.

11. Control cabinets shall not be used as pull boxes or raceways. Wiring gutters and locked terminal cabinets shall be used.

12. The Fire Alarm System wiring shall be installed in a workmanlike manner, subject to the approval of the project manager.

13. All harnessing of wires shall be accomplished by use of approved nylon tie wraps.

14. All wiring shall be numbered, and color coded in accordance with this Specification and approved submittal drawings.

15. Tests of all wiring shall be conducted for proper connection, continuity, and resistance to ground. The minimum allowable resistance between any two conductors or between conductors and ground is one (1) megohm as checked by a "megger" after all conduit, conductors, detector bases, etc. have been installed, but before the detector devices are plugged into the base or end-of-line devices installed.

E. Routing:

1. All fire alarm system conduits shall be installed either parallel or perpendicular to building structural members.

2. All fire alarm system conduits shall be provided at a height so as not to obstruct any portion of a window, doorway, stairway, or a passageway, and shall not interfere with the operation of any existing mechanical or electrical equipment.

3. All fire alarm system conduits and cable shall be routed to minimize the potential for physical damage, either mechanical or by fire.

4. All fire alarm system conduits, junction boxes and cable shall be concealed where possible.

5. All fire alarm system junction boxes, pull boxes, terminal cabinets, control enclosures and device backboxes shall be readily accessible for testing, service and maintenance.

F. Wall, Floor and Ceiling Penetrations:

1. All conduit penetrations of walls shall be provided with escutcheon plates on either side of the wall.

2. All conduit penetrations of walls, floors, and ceiling shall be sealed around the conduits, restoring the walls, floors and ceilings to their original condition, fire resistance and integrity.

G. Concealment:

1. Conduit shall be concealed except where shown on the drawings.

2. All conduit, raceways, junction boxes, panels, electrical enclosures, relays and device backboxes shall be concealed in ceiling spaces, electrical shafts or closets in all finished areas.

3. Conduit, raceways, junction boxes, panels, electrical enclosures, relays and device backboxes may be exposed in unfinished areas.

4. All fire alarm system components, including devices, junction boxes, electrical enclosures, relays and device backboxes shall be provided so as to be readily accessible for inspection, testing, service and maintenance.

H. Terminations:

1. All fire alarm conductor terminations shall be on numbered terminals or terminal strips. All fire alarm conductor terminations shall be within junction boxes, device backboxes, terminal cabinets, control panels or other satiable metal enclosures. Terminals and terminal strips shall be suitable for the size and number of conductors connected to them.

2. All connections and end-of-line devices shall be accessible for inspection, testing and servicing.

3. Terminations to terminals other than barrier/pressure plate type terminals shall use crimp-on ring-type or Y-type spade connectors.

4. Splices shall be permitted only when routing of existing conductors prohibits point-to-point terminations in existing junction boxes, terminal cabinets, etc. All such splices shall be provided with new terminal strips with proper labeling in junction boxes, terminal cabinets, etc.

I. Control Panel Location and Wiring:

1. Install annunciator panels in locations indicated on the drawings.

2. All control panel wiring shall be fully dressed and bundled with nylon tie wraps. Bundled wiring shall be routed parallel to terminal strips within control panels, with individual conductors turned out at 90 degree angles to their associated terminal connections. AC power conductors shall be bundled and routed separately from low voltage conductors. A minimum 2-inch separation shall be maintained between AC power conductors and low voltage conductors wherever possible. All control cabinets shall be sized to accommodate the requirements of this section.

3. Each conductor terminating within a control panel shall be uniquely numbered with durable plastic tags or uniquely identifiable by a combination of numbers and color codes. These conductor numbers shall be shown on the record (As-Built) drawings in a manner allowing ready identification of any field wiring conductor in any control panel.

J. Mounting and Labeling of Devices:

1. All fire alarm devices shall be rigidly mounted, using appropriate backboxes, to building structural members, permanent walls, ceilings or fixtures designed for the purpose.

2. All devices shall be labeled with device address or device count as appropriate. Label shall be sticky back type attached to base of device. Label identification shall be consistent with As-Built drawings.

3. All addressable control modules shall be labeled with the device being controlled and the location of that device.

K. Color Coding and Wire Numbering:

1. All conductors entering and leaving terminal cabinets and junction boxes shall be numbered in a logical and consecutive manner.

2. All conductors shall be color coded. Color coding shall be by wire insulation, not taping or banding. The numbering and color coding shall be continuous for each circuit wire.

3. Wires shall be numbered at each connection, termination, and junction point. Wire numbering tags shall be Brady Perma-Code, Westline, or equal.

4. Color coding shall be as follows:

CIRCUITS	COLOR CODES
Alarm Initiating Circuits	Yellow (-) and Orange (+), red (alarm) blue (alarm)
Horns, 24VDC	Slate(-) and Brown (+)
Smoke Detector	Yellow (-) Orange (+) red (alarm) blue (alarm)
Heat Detectors, Pull Stations	Purple (alarm) Black (alarm), connected to the same zone
Fan Shutdown	Blue (-) White (+)
Strobes, 24VDC	Violet (-) and Pink (+)
System AC Power	Black and White
Sprinkler Horn	Black and White
Valve Supervision	Orange and Yellow
DC Power, Door holds	Black (-) and Red (+)

3.2 INTERRUPTIONS TO EXISTING FIRE ALARM SYSTEM

A. General:

1. Do not remove any portion of the existing fire alarm system from operation while installing new work without written approval of the Owner's Representative.

2. Pupil occupied spaces must have existing systems maintained during school operation.

3. In order to meet the above requirements, provide temporary wiring and relocations of existing and/or new equipment as required. These temporary locations shall be approved by the Owner's Representative and arranged to maintain the required system coverage.

3.3 TESTING

A. General:

1. After complete installation of the equipment and submittal of as-built drawings, the Contractor shall perform complete tests of the system. After these tests have been completed, the Contractor shall request final acceptance inspection and tests in the presence of the Project Manager and local authority. Coordination of final acceptance test date and times with those to be present is the responsibility of the Contractor. The Contractor shall demonstrate that all conditions of the plans and specifications have been met. The tests shall include proper operation of all devices and testing of supervised circuits. The installation will be checked against the as-built drawings. The Contractor shall furnish all testing materials and instruments. A punch list will be developed and the Contractor shall correct punch list items. There will be a reinspection of punch list items. If additional reinspection's are found necessary to assure compliance with the Contract, they shall be made at the Contractor's expense.

    a. The Contractor shall provide, at no additional cost to the Contract price, the following services by the Manufacturer's representative:

        1) Prior to the final inspection, "pre-test" the entire fire alarm system to assure that all new equipment is properly installed and functions in accordance with plans and specifications.

        2) The Manufacturer's representative shall certify that the entire new and existing installation was tested and performed satisfactorily.

2. Final acceptance tests shall be coordinated by the contractor and performed in the presence of the owner's representative as follows:

    a. Operation of the fire alarm control panel and indicating components in accordance with factory recommended procedures.

    b. Operational tests of all devices (i.e., detector, waterflow indicator, manual pull box, and valve supervisory device) in accordance with the factory recommended procedures.

    c. Audible/visible testing of all indicating appliances. Tests shall include sound level (dBA) and light intensity (lumens). Audible testing shall be performed and documented for each space with any doors closed.

    d. Checks of each initiating circuit or device address for correct indications at the control unit, and any remote annunciator.

    e. A checkout report shall be prepared by the contractor and submitted to the Owner's Representative. The checkout report shall include a listing of detector sensitivity for each detector. The report shall summarize the results of all tests and shall serve as the contractor's certification that the system is properly installed and fully functioning

B. Installation contractor shall provide a “Statement of Compliance Letter” to Authority Having Jurisdiction prior to scheduling any acceptance testing, per NYS Fire Code. “Statement of Compliance Letter” shall indicate that the fire alarm system was installed per all applicable codes and standards as well as per the contract documents. Acceptance testing shall not be scheduled without providing the “Statement of Compliance Letter” to the AHJ.

C. The complete fire protection system shall be fully tested and guaranteed for a period of one year after Owner's Representative written acceptance.

D. Prior to acceptance testing the contractor shall complete and submit the “Record of Completion” form as identified in NFPA 72.

E. An acceptance test of the complete system shall be conducted by the contractor and fire alarm equipment vendor/installer as directed by the owner after the system has performed a 100% Pre-Test. Submit a written test report from an authorized representative of the equipment manufacturer that each device and overall system operation has been 100% tested and approved.

3.4 IDENTIFICATION

A. All system devices shall be labeled in the field.

B. For each smoke detector, heat detector, flame detector, duct mounted type smoke detector, manual pull station and/or other alarm initiating device, provide the following:

1. Adhesive backed, vinyl cloth, numbered labels, identifying the device specifically by system address.

2. Labels shall be white background color with solid black numbers. Numbers shall be not less than 5/8" high x 1/8" stroke wide.

3. Design Equipment: Seton Nameplate Co.- Style M3847 or equivalent.

C. For each shut down relay and/or auxiliary control relay and for specific remote lamps, provide the following:

1. Adhesive backed, engraved lamicoid type labels specifically identifying what the fan shut down relay is shutting down, what relay is controlling or what the remote lamp is connected to.

2. Labels shall be black face with white sandwich color, nom: 1/2" tall x 2" wide, with capital letters not less than 3/16" tall engraved into the surface.

3. Design Equipment: Local fabrication by contractor.

D. Provide labels for all smoke detectors that activate elevator recall, smoke hatch operation or fireman’s car operation.

E. All addressable control modules shall be labeled with address, the name of the device being controlled and the location of that device.

F. All labels shall be visible once device is installed.

G. Provide label on each power supply indicating power supply designation, 120 volt panel and associated circuit breaker number.

H. All concealed covers for all system outlet and pull boxes installed shall be factory or field painted red.

1. On the inside face of each outlet box cover, Contractor shall provide labeling, indicating; System address, Circuit Number, Horn/Speaker/Strobe Circuit Number, etc.

I. Provide identification of each circuit breaker feeding on each FACP, Notification Appliance Power Supply Panel and Notification Appliance Power Supply Extender Panel indicating that the circuit feeds the fire alarm system per NFPA 72 by marking in RED "Fire Alarm System".

3.5 CLEANING AND ADJUSTMENT

A. Remove paint splatters and other spots, dirt, and debris. Clean unit internally using methods and materials recommended by the manufacturer.

B. Occupancy Adjustments: Within one year of the date of Substantial Completion, provide on-site assistance in adjusting sound levels, controls, and sensitivities to suit the actual occupied conditions.

3.6 CENTRAL MONITORING AND PROGRAMMING REQUIREMENTS

A. Provide communication wiring from the fire alarm panel digital communicator to the telephone system utility demark. Provide all cross connects to establish two independent phone line connections. Coordinate phone lines with the owner to their selected central monitoring agency.

B. Provide documentation of all FACP messages. FACP messages must be approved by the engineer and owner's representative, prior to start of system programming. Provide custom messages and alarm coding as directed by the owners selected central monitoring agency.

C. FACP descriptors utilize room/space designations and numbers to be used by the facility after occupancy and those descriptors shall be approved by the engineer and Owner's representative. Descriptors shall be no longer than (1) full line of characters on the FACP display and shall contain the room number and room use type.

D. Contractor shall allow for two fire alarm system re-programming as directed by the Owner's representative. Contractor shall include all time and travel expenses for (2) two all day site visits for system re-programming during the warranty period.

E. Provide all required alarm and supervisory alarm output settings to the owners selected central monitoring agency.

3.7 RECORD DOCUMENTS

A. Provide complete set of as-built record drawings and documents.

B. Record Documents shall include all documents required by the Submittal Section of this specification updated to reflect as-built project conditions.

C. Prior to request for final payment submit a quantity of bound Operator Manuals that shall include as a minimum:

1. All documents required by the Submittal Section of this specification updated to reflect as-built project conditions

2. Final Bill of Material.

3. Instruction report stating when instruction was given and who was in attendance, signed by the Owner's Representative. Provide written operator instructions for basic system operation, interpretation of system outputs, operation of manual evacuation signaling and ancillary controls and the use of drill functions (if applicable).

4. Detailed description of routine maintenance and testing as required and recommended for each type of device installed. Maintenance guide shall include:

a. Listing of each individual device that requires periodic testing and maintenance.

b. Step by step procedures for the testing and maintenance for each device listed.

c. Schedule for the testing and maintenance as recommended by NFPA 72 for each device listed.

5. Submit a written test report from an authorized representative of the equipment manufacturer that each device and overall system operation has been 100% tested and approved. Certificate of Completion, Fire Alarm System Inspection and testing form and all other system acceptance documents as described in NFPA-72.

6. Update existing building O&M manuals to indicate new device locations, addresses and signal circuit numbers. Revise and correct existing building manuals to reflect renovations and changes to the existing system.

3.8 WARRANTY AND INSTRUCTION

A. The complete fire protection system shall be fully tested and guaranteed for a period of one year after Owner's Representative written acceptance.

B. Provide 3 sets of keys to all panels, manual stations, etc., to the Owner's Representative.

END OF SECTION 283110

SECTION 311201 - SITE PREPARATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

The general provisions of the Contract, including General and Supplementary Conditions and General Requirements (if any), apply to the work specified in Division 31, 32 and 33.

1.2 DESCRIPTION OF WORK

A. The extent of site preparation is shown on the drawings.

B. Site preparation work includes, but is not limited to, the following:

1. Site investigation and underground utility identification (GPR)
2. Vacuum Excavation (utility locating)
3. Protection of existing trees, shrubs, ground covers and lawns to remain
4. Topsoil stripping and stockpiling on site (See Section 329201)
5. Site clearing and removals
6. Saw cutting
7. Relocations/salvaged materials
8. Clean up

C. Provide materials, labor, equipment and services required to accomplish related work in accordance with the drawings and specifications.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Section 312201 - Site Earthwork

B. Section 329201 – Sodded Lawns

C. Section 334001 - Storm Drainage

1.4 SITE INVESTIGATION

A. The Contractor shall visit the site before bidding, inform and familiarize themselves of all site conditions, including but not limited to, site topsoil, sub-soil, rock, subsurface and groundwater conditions affecting proposed work. No allowance or additional cost will be made in the work of this contract for failing to determine overall project site conditions.

B. Verify locations and protect utilities and structures, whether or not shown on the drawings. Existing utilities and structures shown on the drawings are for the Contractor's convenience and locations are not guaranteed.

C. Verify survey information given on drawings. Walk the site with the Owner's Representative to discuss approximate locations of reputed utilities shown and not shown on the survey, prior to performing work. The Contractor shall provide and perform Ground Penetrating Radar (GPR) utility location within an area of approximately 5,000 sf, as directed by the Architect and Owner, prior to performing any excavation. Notify the

Architect and Owner of any and all discrepancies prior to ordering materials and commencing any work. Commencement of any work will be construed as complete acceptance of survey information.

D. Provide Vacuum Excavation (SoftDig or similar) utility locating holes in two (2) locations onsite in areas as directed by the Architect and Owner.

E. Contractor shall provide Test Pits at all connection points at existing utilities and at all utility crossings to verify utility locations, size, type, invert, and elevations PRIOR to ordering and taking delivery of materials for construction. Notify the Architect and Owner of finding immediately. Contractor shall furnish all labor and materials to accomplish at no additional cost to the Owner.

F. Locate and protect from disturbance existing survey monuments, pins, markers, and benchmarks whether or not shown on drawings. When any disturbance or damage occurs, notify Architect in writing within 24 hours. Describe nature of disturbance or damage and date first occurred. Provide copies to applicable government and municipal agencies. Pay costs for restoring monuments to satisfaction of said agencies, at no additional expense to the Owner.

G. Contractor to model, coordinate, and verify all survey control points. If necessary, provide new or additional survey control points to synchronize any site model with real world coordinates at no additional cost to the Owner.

1.5 JOB CONDITIONS

A. The terms "Architect" and "Landscape Architect" for Divisions 31, 32 and 33 work shall mean Appel Osborne Landscape Architecture, 102 West Division St., Suite 100, Syracuse, NY 13204, Tel. (315) 476-1022. Facsimile (315) 479-7573 or other representative(s) that King and King Architects may determine.

B. Examine drawings and specifications for the entire project. Become familiar with the scope and sequencing of work required. Coordinate and cooperate with other Contractors and trades working in and adjacent to the project.

C. Examine work prepared prior to this contract. Commencement of work will be construed as complete acceptance of all preparatory work by others.

D. Obtain and pay for permits required by authorities. Perform the work in compliance with applicable standards, codes and requirements of governing authorities having jurisdiction.

E. Safety is the sole responsibility of the Contractor.

F. Burning on site and use of explosives are not permitted.

G. Responsibility for existing utilities:

1. Contact Dig Safely New York at least two (2) full working days, and not more than ten (10) working days, before digging begins or as required by latest state law. Locate by hand excavation and provide protection from damage to existing utilities to remain in the area. (Tel. 811)

2. Existing utilities encountered within excavated areas shall be supported, blocked and/or braced in a manner approved by the owner of the utility. Leave supports in place to the extent required by the owner of the utility.

3. Should uncharted or incorrectly charted utilities be encountered, notify the Architect immediately for directions as to procedure.

4. Do not break utility connections without providing temporary services as acceptable to the Architect and the owner of the utility.

5. Repair and pay for damages to existing utilities as directed by utility Owner at no additional cost to the Owner.

6. Cap ends of utilities to be abandoned or removed in accordance with regulatory agencies and as directed by the Architect.

H. Provide protections and conduct operations to prevent injury and damage to persons, work of other Contractors, existing items to remain, structures, pavements, lawns, and adjacent properties.

I. Restore work damaged by this Contractor inside and outside the contract limits to the condition existing prior to the start of work, unless otherwise directed, to the satisfaction of the Architect at no additional cost to the Owner.

J. Vehicular and pedestrian traffic control:

1. Maintain vehicular and pedestrian traffic during construction activities.

2. Provide alternate routes and traffic control around closed and obstructed traffic ways as required by governing regulations or the Owner.

3. Provide temporary fencing, flagpersons, barricades, warning signs, and warning lights or other measures to protect the public and cause the least interruption of work.

K. Field Measurements: Take necessary field horizontal and vertical measurements required in order to perform the work and design intent shown on the drawings, and outlined in the specifications. Assume complete responsibility for accuracy of such measurements and dimensions.

L. Removal of spoils, dust control, debris and clean up:

1. Control air pollution caused by dust and dirt; comply with governing regulations. Water to control dust when necessary and as directed by the Architect or Certified Erosion Control Specialist. Provide water sprinkling materials, equipment and labor to prevent the nuisance of dust to the surrounding areas.

2. Legally dispose of removed and demolished items, including trash and debris, off the Owner's property, at a licensed disposal facility having adequate capacity to accept the project's waste.

3. Burning of combustible materials on the site is not permitted.

4. During the contract and at intervals as directed by the Architect, clear the site of extraneous materials, rubbish, construction waste, and debris. Leave the site in a clean, safe, neat, well-draining condition.

5. Soil Removal: Sweep roads, access ways, paved areas, and parking areas where soil, mud and debris have dropped or tracked from construction and delivery vehicles on a daily basis and as directed by the Architect or Certified Erosion Control Specialist.

6. Spoils: Remove from site and dispose when not required for fill or determined to be unsatisfactory soil material per Section 312201 - Site Earthwork.

M. Construction Review - General: Site visits will be made by the Architect to observe construction conformance to drawings and specifications. The occasional site visits by the Architect shall not be construed as supervision of construction or make them responsible for the safety programs and precautions, including but not limited to: the safe access, visit, use, work travel, or occupancy of any person. Site visits shall not make the Architect responsible for means, methods, techniques, sequences or procedures of construction selected by the Construction Manager, Contractor or his Sub-contractors.

N. Site Complexity: The existing site will be intensively developed. Because of the construction and resulting graphic complexity, it is impractical to show every detail. However, the general design intent is clearly shown and shall be applied to individual conditions not specifically shown as directed by the Architect and at no additional cost to the Owner.

O. Asbestos, Toxic and Hazardous Materials: The Division 31, 32 and 33 site work contract does not include testing for, handling or removal of hazardous materials such as, but not limited to: asbestos, fuel, oil, PCB's, or other toxic or hazardous waste materials as identified by the EPA and/or NYSDEC. If any such materials are encountered during any part of the site work, the Contractor is responsible for identifying potential hazardous material and immediately notify all governing agencies having jurisdiction as required by law. Also, within one (1) hour of discovery notify the Architect, Landscape Architect, Consultants, and Owner. The Owner shall provide testing and removal by others, under separate contract. The Contractor shall recommence work under this contract when the Owner provides written certification that remediation is complete per governing agency. The Contractor shall not be penalized for any delays caused by the hazardous testing and removal, unless such hazardous material incident was a result of Contractor's operations. The Contractor shall indemnify and hold harmless the Architect, Landscape Architect, Consultants and Owner, agents, and employees from and against all claims, damages, losses and expenses, direct and indirect or consequential damages, including but not limited to fees and charges of attorneys and court and arbitration costs, arising out of or resulting from the performance of the work by the Architect, Landscape Architect, Consultants and Owner, or claims against the Architect, Landscape Architect, Consultants and Owner arising from the work of others, related to hazardous waste.

The above indemnification provision extends to claims against the Architect, Landscape Architect, Consultants and Owner which arise out of, are related to, or are based upon,

the dispersal, discharge, escape, release or saturation of smoke, vapors, soot, fumes, acids, alkalis, toxic chemicals, or pollutant in or into the atmosphere, or on, onto, upon, in or into the surface or subsurface soil, water or water courses, objects, or any tangible or intangible matter, whether sudden or not.

Should the hazardous material incident be the result of the Contractor's operations, the Contractor shall be responsible for all costs associated with the discovery and remediation of such hazardous material such as, but not limited to: testing, consultant fees, damage, loss, fees and charges of attorneys, court and arbitration costs, claims by other contractors, direct and indirect or consequential damages.

P. Salvageable Items: Remove at any time after work starts. Storage or sale on site of salvageable and removed items is not permitted. Do not remove topsoil from site without written permission from the Owner.

1.6 SUBMITTALS

A. Provide photographic documentation. Photographically document existing features which, may be affected by the construction, inside and outside the contract limit line. Existing features include, but are not limited to: structures, pavements, curbs, utilities, lawns and vegetation, especially individual trees which are over six (6") inches in diameter and noted to remain on the drawings. Also, particular attention shall be paid to the construction access, stockpile and haul road areas. Distribute a copy of the photographic documentation (digital format) to the Owner and Architect prior to the start of construction.

PART 2 - PRODUCTS

2.1 PROTECTIVE DEVICES

A. Shall include, but not be limited to; plastic fence, temporary chain link fence and gates, wood planks, rubber mats, barriers, lights, barricades, coverings, traffic controls, steel plates, and other temporary protections.

B. Contractor to provide all necessary protections required by Occupational Safety and Health Administration (OSHA).

PART 3 - EXECUTION

3.1 PROTECT EXISTING VEGETATION TO REMAIN

A. Prior to commencing site preparation work, notify Architect, and meet on site to locate existing trees, lawns and vegetation which are to remain.

B. Protect and keep existing vegetation to remain free from physical damage. Keep in a healthy, vigorous growing condition for the entire construction period as follows:

1. Keep site disturbance and staging limits to a minimum. Obtain approval from Owner for material and equipment storage areas. Limit access points and routes to the project site. Coordinate site access with other trades and contractors on the work site.

2. Groups of Trees and Vegetation: Place orange plastic construction fencing around drip line(s) of trees and plant beds as detailed or directed by the Architect. Do not store materials, run equipment, park vehicles, or otherwise disturb area within the drip line (full canopy of tree) or in plant beds.

3. Specimen and Individual Trees: Protect each as noted and detailed. Do not store materials, run equipment, park vehicles or otherwise disturb area within the drip line (full canopy of tree).

C. Rejuvenate damaged vegetation by pruning watering, fertilizing, staking and other methods as directed by the Architect. Replace trees and other vegetation that cannot be restored to full growth with comparable size, quantity, quality and species as determined by the Architect.

D. Repair lawns disturbed due to construction operations outside the grading limits, as specified and directed by the Architect. Provide screened topsoil, seed, and mulch over damaged lawn areas, access ways or where tire rutting occurred.

3.2 TOPSOIL STRIPPING AND STOCKPILING ON SITE

A. Strip full depth of existing topsoil from areas to be regraded, paved, or otherwise built upon. When amount of available topsoil exceeds what is indicated in geo-tech/boring report, on site test pits, or Contractor assumed depth, continue to remove all topsoil and lower the paved or built element subgrade. Place additional satisfactory earth fill in uniform depths as indicated in the Site Earthwork Section 312201. Maintain finished grades as shown on the drawings. This work shall be done at no additional cost to the Owner.

B. Minimum quantity of topsoil shall be as needed to provide four (4") inches settled depth on lawn areas. Verify quality and quantity. Supply imported topsoil when amount of available topsoil meeting above requirements is less than what is required for the proposed lawn areas. See Section 329201 for imported topsoil requirements.

C. When amount of available topsoil meeting above requirements exceeds what is required for the proposed lawn areas, lower the lawn subgrade and place additional topsoil in a uniform depth as directed by the Architect. Maintain finish grades as shown on the drawings. This work shall be performed and supplied at no additional cost to the Owner.

D. Topsoil shall be well drained, homogeneous texture soil of uniform grade, without the admixture of subsoil material. Topsoil shall be free of dense material, hardpan, and stone over three-quarters (3/4") inch in diameter, and other objectionable foreign material including, but not limited to, brick, concrete, asphalt, glass, nails, screws, toxins, hazardous wastes and chemicals (such as, but not limited to, atrizene and muriatic acid) that may be injurious to humans, animals and plant materials.

E. Stockpile on site where shown on the drawings or as directed by the Owner. Provide all hauling as necessary. Do not mix topsoil stockpiles with other materials. Do not remove topsoil from site without written permission by the Owner. Stabilize and maintain all stockpiles as specified.

3.3 SITE CLEARING AND REMOVALS

A. Items and materials noted to be removed shall become the property of the Contractor, unless otherwise noted. Obtain Owner's approval prior to removal off site or for relocation of salvaged material on site. Remove material off site and legally dispose of it. Backfill voids with imported granular backfill, placed in eight (8") inch layers compacted to 95% maximum density.

B. Remove physical elements above and below grade as shown and which interfere with proposed construction. Physical elements include but are not limited to: trees, root systems, shrubs, vines, grass, vegetation, pavements, walks, curbs, gutters, foundations, previous construction materials, glass, headwalls, flared end sections, catch basins, manholes, inlets, drywells, septic tanks, unused utilities, pipes, cisterns, walls, rocks, and other debris.

C. Trees, shrubs and roots shall be completely removed and disposed of legally off site.

D. Maintain existing utilities shown to remain and protect from damage during demolition and construction operations. Do not interrupt existing utilities; provide temporary services when required, as acceptable to the Architect.

E. Research with Owner possible locations of existing subsurface utilities prior to excavating.

3.4 SAW CUTTING

A. The Work consists of vertical saw cutting of the existing asphalt or concrete pavement structure to facilitate the removal of the asphalt or concrete bound material.

B. The equipment shall be capable of producing a smooth vertical saw cut without causing damage to the adjacent pavements or related site features.

C. The Contractor shall saw cut the asphalt/concrete pavement to a depth which will allow removal of the material without causing damage to the adjacent pavement. Rough, jagged or cracked edges will not be acceptable. Concrete pavement shall be removed at the nearest contraction joint.

3.5 RELOCATIONS

A. Any item noted to be relocated shall be removed by the Contractor from its existing position without damaging it, stored, protected from theft, fire, vandalism and damage for the project duration. Reset in the location(s) and in the manner detailed, noted on the drawings or specified.

B. Backfill voids with imported granular fill material, placed in eight (8") inch layers compacted to 95% maximum density when located in proposed pavement areas or 90% maximum density when located in proposed non-paved areas.

C. Salvaged items shall be returned to the Owner as noted on the drawings. Move items to Owner designated areas.

3.6 CLEAN UP

During the contract and at intervals as directed by the Architect and as site preparation is completed, clear the site of extraneous materials, rubbish, and debris. Leave the site in a clean, safe, well draining, neat condition.

END OF SECTION 311201

SECTION 312201 - SITE EARTHWORK

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. The extent of site earthwork and site grading is shown on the drawings.

B. Site earthwork includes, but is not limited to, the following:

1. Fill Materials
2. Source Quality Control
3. Shoring, Bracing and Supporting
4. Horizontal and Vertical Layout
5. Grading and Excavation
6. Compacted Backfill and Fill
7. Field Quality Control Testing and Inspection Services
8. Guarantee
9. Clean Up

C. Provide materials, labor, equipment and services required to accomplish related work in accordance with the drawings and specifications.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 311201 - Site Preparation

B. Section 312501 - Erosion, Sediment and Pollution Control

C. Section 334001 - Storm Drainage

1.3 REFERENCES

A. AASHTO T 180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54 kg (10-lb) Rammer and a 457 mm (18 in.) Drop; American Association of State Highway and Transportation Officials

B. ASTM C 136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

C. ASTM D 75 - Practice for Sampling Aggregates

D. ASTM D 422 - Particle-Size Analysis of Soils (without Hydrometer Analysis)

E. ASTM D 698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3)

F. ASTM D 1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3)

G. ASTM D 2434 - Standard Test Method for Permeability of Granular Soils (Constant Head)

H. ASTM D 2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)

I. ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

J. ASTM D 3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

K. ASTM D 6938 - In Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods

L. ASTM D 4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

M. ASTM D 5084 - Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.

N. Occupational Health and Safety Administration Regulations and Standards

1.4 SUBMITTALS (See Section 311201, 1.5)

A. Furnish name of New York State licensed Land Surveyor to be employed and perform project layout. Obtain Architect's approval prior to performing work.

B Submit written report on NYS licensed Land Surveyor's letterhead verifying that professional's involvement with the project layout. The report shall briefly state the scope of services performed for the project, the dates work was accomplished, and an explanation of any adjustments required, specifically listing as-built and FIELD VERIFY requirements as noted in 3.2 of this specification section.

C. Provide Earthwork Contractor's experience requirements as indicated in 1.5, "Quality Assurance". Obtain Architect's approval prior to performing work.

D. Samples: 10 lb. samples of each type of fill; submit in airtight containers to testing laboratory.

E. Materials Sources: Submit name of imported materials source for each type of fill material.

F. Fill Composition Test Reports (Imported and Onsite): Provide results of laboratory tests (less than 2 months old) on proposed and actual materials used to determine acceptability. This shall include:

1. One optimum moisture-maximum density curve (Modified Proctor) for each soil/imported fill type as determined by ASTM D1557, Method A, latest issue.
2. Sieve Analysis - ASTM D422
3. Moisture Density Relationship - ASTM D1557, Method C / ASTM D698
4. Plasticity Index - ASTM D4318
5. Soundness Test - ASTM C88

6. Soil Classification - AASHTO and ASTM D2487

G. Compaction Density Test Report(s) required in Field Quality Control of this specification.

H. Contractor's NYS Licensed Professional Engineer's layout and design calculations of sheet piling and shoring required.

I. Retaining Wall Permeability Testing: Engage an independent testing agency to perform one (1) permeability test of retaining wall backfill as determined by ASTM D2434 and ASTM D5084. Results shall meet permeability for retaining wall backfill > 3"/hour at a minimum.

1.5 QUALITY ASSURANCE

A. Perform all site earthwork, site grading and excavation in compliance with requirements of governing authorities having jurisdiction, OSHA Standards, and "References" in this project specification.

B. The Owner will employ a licensed soil testing and inspection service for Field Quality Control Testing of materials. This Contractor will coordinate day to day scheduling with the Owner's testing agency for conformance with "Field Quality Control Testing and Inspection Services" in this project specification.

C. Earthwork Contractor Experience Requirements: Submit business name, business Owner(s) name(s), business address, telephone number, website and/or email address signed by the Contractor/Subcontractor who meets the qualifications set forth in this specification and is proposed by the Contractor to perform the Earthwork for this Project. Provide a list of at least four (4) Earthwork projects of comparable size, scope and quality completed successfully by the proposed Contractor/Subcontractor within the past three (3) years that includes the date completed, project Owner's name and current contact information, including telephone numbers and email addresses.

D. Layout Foreman Experience: The Earthwork Contractor must provide a competent layout foreman skilled in this specific type of layout/earthwork project. The layout/earthwork foreman shall have a minimum of four (4) similar projects completed within the last three (3) years. Provide a list of projects layout/earthwork foremen has completed including project name, address, Owner contact information and project scope of work.

1.6 JOB CONDITIONS

A. Job conditions in Section 311201 apply.

B. Provide sufficient quantities of fill materials to meet project schedule and requirements. When necessary, store materials on site in advance of need.

C. When fill materials need to be stored on site, locate stockpiles where directed by Owner.

1. Separate differing materials with dividers or stockpile separately to prevent intermixing.

2. Prevent contamination of material types.

3. Protect all stockpiles from erosion and deterioration of materials by covering with plastic sheets, tarps or as directed by the Architect.

D. Moisten or dry, fill or backfill materials, to the proper moisture content as determined in accordance with ASTM D1557, Method C in order to obtain proper compaction as indicated.

E. The Contractor shall familiarize him/herself with results and information contained within the Geotechnical Data & Attachment Report. These onsite soils are very sensitive to moisture and vibration. The Contractor shall take note and anticipate these soils will lose strength and mitigate in the presence of water and normal construction traffic and may turn into a "quick" condition (i.e. complete loss of shear strength and turning into a liquid-like condition). Achieving satisfactory compaction on these soils will be difficult, especially during wet conditions. This condition shall be taken into account within the Contractor's bid and schedule.

1.7 SUB-SURFACE SOIL INFORMATION

A. Refer to subsurface information elsewhere in the specifications. The geo-technical data on subsurface conditions is not intended as representation warranties of the continuity of such conditions between test pits or test borings made by the Owner and included in the specification. It is expressly understood that the Owner, Architect, Landscape Architect, and Consulting Engineers are not responsible for interpretations or conclusions drawn therefrom by the Contractor. The data is made available for the convenience of the Contractor.

B. Additional test borings and other exploratory operations may be made by the Contractor at no additional cost to the Owner, provided such operations are acceptable to the Architect and Owner. Coordinate test locations with Owner prior to starting work. Backfill immediately when completed and repair to satisfactory conditions as determined by the Architect. It is expressly understood that the Owner, Architect, Landscape Architect, and Consulting Engineers are not responsible for interpretations or conclusions drawn therefrom by the Contractor.

1.8 UNUSUAL SUBSURFACE CONDITIONS

A. Notify the Architect immediately in writing via email when unusual conditions are encountered during excavation, including, but not limited to: excessive flooding, miscellaneous structures, uncharted or unlocated utilities, foundations, bed rock, toxic and hazardous materials and chemicals (such as muriatic acid and atrizene), suspected archaeological artifacts, and unsatisfactory soil materials. Request clarification from the Owner's Representative or Architect before proceeding. Refer to paragraph 3.4 of this specification.

PART 2 -PRODUCTS

2.1 FILL MATERIALS

A. **Satisfactory General Earth Fill:**

1. To be used at least 5'-0" outside of structural elements.

2. Satisfactory general earth fill shall be satisfactory on-site subsoil, or hauled in off-site subsoil free of toxics, hazardous wastes and chemicals (such as, but not limited to, atrizene and muriatic acid) that may be injurious to humans, animals and plant materials. Satisfactory earth fill shall also be free of rubbish, debris, wood, masonry, metal, frost, vegetation, organics or other deleterious material, which cannot be properly compacted. Use satisfactory general earth fill that is dry and free of clay. Rocks, gravel or soil shall not be larger than 3" in any dimension/direction.

3. Satisfactory earth fill materials are also defined as those complying with the American Association of State Highway Transportation Officials (AASHTO), M-145 soil classification Groups A-1, A-2-4, A-2-5, A-3 and Unified Soil Classification System GW, GP, GM, GC, SW, SP, SM, and SC (or a combination of these group symbols) as determined by ASTM D2487.

B. **Imported Granular Backfill:**

1. Imported granular backfill to be used for asphalt pavement subbase, concrete subbase, storm structures, storm pipes, other structures, and where indicated on the drawings.

2. Backfill shall be run of crusher stone meeting the following gradation as determined by ASTM-C136:

Standard Sieve Sizes	Percent Passing By Weight
2" or 50 mm	100%
3/4" or 19 mm	75 - 90%
1/4" or 6.3 mm	25 - 60%
#40 or 0.425 mm	5 - 40%
#200 or 0.075 mm	0 - 8%

3. Backfill shall be free of debris and deleterious materials. In no case shall the plasticity index exceed 5.0 or the percentage passing the 200 mesh sieve exceed 8%. The quality of the imported granular backfill shall be determined by the magnesium sulfate soundness test, if considered suspect by the Architect or Geotechnical Engineer. The maximum percent loss at four cycles by weight shall be 20.

C. **Stormwater Management Trench (SMT) Backfill:**

1. Shall be No. 1 clean, washed, crushed stone or crushed gravel meeting the following gradation as determined by ASTM C136:

Standard Sieve Size	Percent Passing By Weight

1" or 25.0 mm	100%
1/2" or 12.5 mm	90-100%
1/4" or 6.3 mm	0-15%

D. **Retaining Wall(s) Backfill:**

1. Shall be run-of-crusher hard durable limestone having a gradation by weight in accordance with ASTM C-136, within the following limits:

Standard Sieve Sizes	Percent Passing By Weight
2" or 50 mm	100%
3/4" or 19 mm	75 - 90%
1/4" or 6.3 mm	25 - 60%
#40 or 0.425 mm	5 - 40%
#200 or 0.075 mm	0 - 2%

2. Backfill shall be free of debris and deleterious materials. In no case shall the plasticity index exceed 5.0 or the percentage passing the 200 mesh sieve exceed 2%. The quality of the retaining wall backfill shall be determined by the magnesium sulfate soundness test, if considered suspect by the Architect or Geotechnical Engineer. The maximum percent loss at four cycles by weight shall be 20.

3. Material shall have a permeability of 2.4"/hour (1.7 x 10-3 cm/s) or greater when compacted to required density.

2.2 UNSATISFACTORY SOIL MATERIALS

A. Shall be defined as soil with high percentage of decomposed rock, sand, organic matter or moisture laden clay to prevent adequate compaction. Also, soil with toxics, hazardous wastes and chemicals (such as atrizene and muriatic acid) that may be injurious to humans, animals and plant materials. Also, soil with significant quantities of rubbish, debris, wood, masonry, metal, frost or other deleterious material which, in the opinion of the Geotechnical Engineer, Owner's Representative, and Architect, cannot be properly compacted shall be classified as unsatisfactory.

B. Unsatisfactory soil materials are defined as those described in AASHTO M-145, soil classification, Groups A-2-6, A-2-7, A-4, A-5, A-6, and A-7 with CBR value less than 7.0. Also Unified Soil Classification System ML, CL, OL, MH, CH, OH as determined by ASTM D2487 (or a combination of these group symbols) with CBR value less than 7.0 in addition to peat (PT) and other highly organic soils, cobbles, boulders; and soil materials, of any classifications that have a moisture content at the time of compaction beyond the range of 1% below and 3% above the optimum moisture content of the soil material/backfill material, as determined by the Moisture Density Relationship test.

C. When unsatisfactory soil materials are encountered at proposed subgrades and other design elevations, proceed as described in Part 3 (Execution) of this Section.

D. When excavated materials become unsatisfactory as a direct result of the Contractor's work, this shall result in the rejection of the unsatisfactory soil materials by the Architect.

E. The use of slag (a byproduct of metal processing) or recycled/crushed concrete is unacceptable for any use on this project site.

2.3 SOURCE QUALITY CONTROL

A. See "Submittals" and "Quality Assurance" of this specification section for general requirements for testing and analysis of soil and fill materials.

B. Where fill materials are specified by reference to a specific standard, Contractor is responsible to test and analyze all samples for compliance before delivery to site.

C. If tests indicate materials do not meet specified requirements, change material and retest until approved.

2.4 SHORING, BRACING AND SUPPORTING

A. Shoring and bracing shall conform to the requirements of the Occupational Health and Safety Act.

B. Shoring and bracing shall be provided, placed and maintained at the locations and elevation that are necessary or required to: support and protect the sides and bottom of the excavation; prevent undue disturbance or weakening of the supporting materials below or beside the works; prevent movement of ground which may disturb or damage the work, adjacent pavements, property, structures or other works.

C. Provide materials for shoring, bracing, and supporting, such as sheet piling, uprights, sheathing, stringers, and cross-braces, in good serviceable condition. Use timbers that are sound and free of large or loose knots.

D. Provide design by Contractor's NYS Licensed Engineer, when shoring is required to perform work as shown on the drawings. Submit to Architect for approval.

E. Installation: Shoring and bracing shall be driven and placed so that it can be removed as backfilling takes place without damage to the pipeline or its appurtenances, structures, and without settlement of or damage to adjacent pavements and structures.

F. Removal: The Contractor shall remove all shoring and bracing as the excavation is backfilled, unless directed by the Architect to be left in place. The procedure for extracting shoring and bracing and placing backfill shall ensure the backfill load is applied gradually, and disturbance of the works or foundation material is avoided.

G. Support all utilities as required by the municipality/utility owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify field conditions such as bench marks, monuments, topography, inverts, locations of utilities and property lines before proceeding. Notify the Architect immediately, in writing, of discrepancies prior to commencing work. Commencement of work will be construed as complete acceptance of survey and layout information. Additional costs resulting from failure to verify field conditions prior to commencing work shall be borne by this Contractor and at no additional cost to the Owner.

3.2 LAYOUT

A. Stake layout up to and including those elevations and dimensions specifically noted on drawings as "FIELD VERIFY" (FV). Ensure that the field elevation and dimension agrees with the elevation and dimension on the drawings before continuing. Notify the Architect immediately, in writing, of any discrepancies prior to commencing work. Additional costs resulting from failure to verify dimensions as noted on drawings shall be borne by this Contractor and at no additional cost to the Owner.

1. Assume sole responsibility for the accuracy of the layout work.

2. Run from point(s) of beginning (POB), base lines, property monuments, benchmarks, iron survey pins, or other points given on the drawings.

3. Roads, Parking Areas, and Walks: Accurately locate and stake curb lines, center line, swales, point of curve and tangency as necessary to accurately build.

4. Buildings and Site Features: Accurately locate and stake corners, offset corners, slopes, and center lines as necessary to accurately build.

5. Pipe Work: Accurately locate with laser.

3.3 GRADING

A. Cut and Fill: Presume the earthwork does **NOT** balance on site. Meet the grades shown on the drawings. Haul in or haul away as may be necessary. Provide earthwork calculations and provide for imported or exported material as part of bid. No additional costs will be allowed.

B. Grade areas as indicated, including transition areas, with uniform levels and slopes between finish elevations.

C. Cut to grades and profiles indicated.

D. Set grade stakes at fifty-foot (50') intervals, at corners, and breaks in grade.

E. Conduct operations to avoid ponding of water. Provide all pumping equipment, sump pits, and temporary diversion swales where and when necessary to continue work performance on schedule and as specified.

F. Shape subgrade surface of site elements to within 0.10' above or below required subgrade elevation, compacted as required and sloped to provide drainage as shown on the drawings. Notify Architect and Geo-Technical Engineer for subgrade review prior to continuing work.

G. Refer to Section 311201 for topsoil requirements.

3.4 EXCAVATION

A. Remove and legally dispose of material encountered to obtain required subgrade elevations, including pavement, obstructions visible on ground surface, underground structures and utilities indicated to be removed.

B. Sloping and Benching: Follow OSHA recommendations based on soil type to determine slope configurations. Slope the sides of excavations five (5') feet deep and over to the angle of repose of the material excavated; otherwise, shore, and brace where sloping is not possible either because of space restrictions or stability of material excavated.

C. Bracing and Shoring:

1. Provide bracing and shoring as required in excavations, to maintain sides and to protect structures from settlement.

2. Maintain shoring and bracing in excavations regardless of the time period excavations will be open. Carry down shoring and bracing as the excavation progresses.

3. Remove shoring and bracing before completion of backfilling except where required for structural support or slope stability.

4. The design, installation, and maintenance of such shoring and bracing required to accomplish the above purpose are the sole responsibility of the Contractor.

5. Follow OSHA recommendations for bracing and shoring.

6. Indemnify the Owner, the Landscape Architect, Architect, and the Consulting Engineers against any action arising from damage to existing structures, utilities or injury to persons resulting from the Contractor's actions or failure to act, in carrying out the intent of this section.

D. Protections: Protect structures, vegetation, utilities, sidewalks, pavements, and other facilities in areas of work. Barricade and secure open excavations and provide warning lights/signage from dusk to dawn each day.

E. Extent of Excavations: Excavate for structures to elevations and dimensions shown, extending excavation a sufficient distance to permit placing and removal of other work and for review. Trim bottom to required lines and grades to provide solid base to receive concrete or imported granular backfill material.

F. Unsatisfactory Soil Materials: When unsatisfactory soil materials, as defined in this specification, are encountered at design elevations, immediately notify the Architect in writing by email or other equally expeditious means. Continue as directed by the Architect and Geo-Technical Engineer. When, in the sole opinion of the Architect, conditions are not a result of Contractor's negligence, additional excavation may be directed by the Architect and paid for as a Change Order on a unit price or negotiated

price basis in accordance with Contract Documents. This additional excavation shall be measured each day and verified by the Owner's representative and the Contractor's Superintendent. A daily written accounting, attested by both parties, shall be maintained with copies daily to the Architect. No claim for extra compensation will be considered except through the procedure outlined above. Assume **25 cy** of undercutting and removals, placement of soil stabilization fabric (SSF) and providing and compacting to 95% density imported granular backfill material in Base Bid. Unit price provided shall be utilized to add to or delete from this assumed quantity to account for actual quantity encountered.

G. Unauthorized and Over Excavation: Consists of removal of materials beyond required subgrade elevations or dimensions without specific direction of the Architect or Geotechnical Engineer. Unauthorized or over excavation, as well as remedial work directed by the Architect or Geotechnical Engineer, shall be at Contractor's expense. Fill of unauthorized excavations shall be as follows (all at no additional cost to the Owner):

1. Fill the voids created by the removal of materials beyond indicated subgrade elevations with lean concrete (2000 psi). Or;

2. Extending the indicated bottom elevation of the concrete footing to the lower elevation. Or;

3. Adding imported granular backfill material compacted to 95% density to proper design elevation and layout as directed by the Architect. Testing agency to perform compaction testing prior to proceeding.

H. Dewatering:

1. Contractor shall anticipate seasonal variations of soil moisture content and groundwater in the Base Bid as verified by site investigation indicated in Section 311201.

2. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

    a. Surface and ground water shall be intercepted and removed before entering excavations. All necessary measures shall be taken. Earth dikes, ditches, or other devices, if required, shall be constructed to prevent such flows.

3. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

    a. 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.

    b. Remove water to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to stability of subgrades and foundations.

c. Provide and maintain pumps, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.

4. The Contractor shall at all times provide and maintain proper and satisfactory means and devices (i.e. ditches, temporary pipes, pumps, and/or other temporary construction) for the removal of all water entering the excavations. Water shall be removed as fast as it may collect, in such manner that shall not interfere with the execution of the work or in the proper placing of pipe, structures or other work.

5. Provide and operate sufficient pumping machinery to keep excavated parts free of water. Dig sump pits when necessary into which the excavation shall be drained. Take care and proper precautions in the use of pumps so that in no case will foundations, footings and utilities already in place or existing foundations, footings of adjacent structures or utilities be undermined or disturbed, and erosion occur due to pumping.

6. Do not discharge pumped materials into any body of water, wetland, adjacent property, roadside swales, subsurface storm systems, or any infiltration practices as determined by the Architect. Provide temporary sediment basins, traps, and filter bags for pumped water.

7. Adjust, repair, replace, or clean all work, surfaces, and property, which may have been affected as a result of any dewatering operation.

I. Prepare subgrade and twelve (12") inches of existing sub-soils below subgrade elevations in excavated areas to minimum density of 95% in structure, pavement, utility areas, trenches, and 90% under lawn non-paved areas.

J. Rock and Rock Excavation:

1. Rock Definition: Shall be defined as solid hard material located in ledges, bedded aggregate deposits and unstratified masses, and all-natural conglomerate deposits so firmly cemented as to present all the characteristics of solid rock, which must be removed by pneumatic hammers. Rock does not include shale, slate, soft sandstone, hardpan, masonry or concrete rubble, boulders less than three (3) cubic yards, such other rock material which is decomposed, stratified, weathered or shattered, or any material capable of being removed by a well maintained Caterpillar 225 power shovel, D8 Dozer with Ripper, or Architect approved equivalent.

2. Rock Excavation Administrative Procedures: When encountered, shall be stockpiled for measurement before removal and paid for on a unit price basis in accordance with Contract Documents. Notify Architect immediately of rock discovery prior to performing any rock removal or continued excavation. Rock excavations as defined shall be measured each day and verified by the Owner's designated representative and the Contractor's on-site Superintendent. A daily written accounting, attested to by both parties, shall be maintained with copies daily to the Architect. No claim for extra compensation will be considered except through the procedure outlined above. Contractor to assume **10 c.y.** of

rock excavation and removal in Base Bid. Unit price provided shall be utilized to add to or deduct from this assumed quantity to account for actual quantity encountered.

3. Rock Excavation Removal Procedures: Includes removal and disposal of rock. Remove rock to lines and grades 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. 8 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.

4. Any over excavation due to rock excavation and removal shall be handled as directed under "Over Excavation" in this Section.

5. Contractor has the option to remove existing rock and dispose off-site or crush existing rock and use as satisfactory general earth fill when it meets gradation noted in 312201 for imported granular backfill material.

3.5 BACKFILL AND FILL

A. Preparation of Ground Surface to Receive Fill: Remove vegetation, organic materials, obstructions, and deleterious materials from ground surface prior to placement of fills. Break up and remove existing foundations, concrete slabs, abandoned utilities, and site features. Plow, strip, roughen, or break up slopes steeper than 1 vertical to 4 horizontal so that fill material will bond to existing surface.

B. Execute these steps when the existing ground surface, after removal of the above unsatisfactory soil materials, has a density less than that specified under "Compaction" for the particular area classification: Break up the ground surface, pulverize, moisture-condition to the optimum moisture content, and compact to the required depth and percentage of maximum density.

C In no case shall fill be placed on a subgrade that is wet, muddy, rutted, spongy, frozen or that contains frost or that has not been tested and approved to achieve satisfactory results.

D. Areas to receive any fill or backfill should be properly prepared, proof rolled, tested per "Field Quality Control" within this specification, inspected and approved by the Architect and Geo-Technical Engineer prior to the placement of fill.

E. Following grade approval by the Architect and Geo-Technical Engineer, place imported granular backfill, imported structural fill and satisfactory general earth fill material in layers not more than eight (8") inches in loose depth in a manner to minimize segregation. The fill shall be placed in nearly horizontal lifts commencing at the lowest fill area elevation and proceeding with each lift upward and outward from the lower lift.

F. Moisture Content: Contractor shall anticipate seasonal variations of all soils (on site or imported) and imported fills moisture content in the Base Bid and timing required for such shall be included in the project schedule. The moisture content of the materials shall be adjusted prior to application of compaction such that it is no more than 1% below or 3% above the optimum moisture content of the material. Apply water to surface, subgrade or layers of soil material when required to achieve compaction densities stated below. Remove and replace, or scarify and air dry, soils or imported materials that is too wet to permit compaction to specified density.

G. Compaction:

1. Compact each eight (8") inch layer of fill and backfill materials.
2. Compact fill and backfill material below subgrade for structures, slabs, pavements, and utilities to minimum 95% of optimum in place density as determined by ASTM D1557, Modified Proctor.
3. Compact fill material below subgrade for lawns or unpaved areas to minimum 90% of optimum in place density as determined by ASTM D1557, Modified Proctor.

H. Equipment:

1. Use sheepsfoot rollers, pneumatic tired rollers, drum rollers, vibrating tampers, and other compaction equipment capable of obtaining the required density throughout the entire layer being compacted.

2. Use power-driven hand tampers for compacting materials adjacent to site structures.

3. For utility trenches or other confined areas, small compaction equipment may be necessary such as a vibratory plate, jumping jack or walk-behind vibratory roller. In these cases, lift heights no greater than six (6") inches should be maintained.

I. Reconditioning Compacted Areas: Where previously completed compacted areas are disturbed by subsequent construction operations (by any Contractor), traffic or adverse weather, scarify and dry out the surface, regrade, and recompact to the required density prior to further construction at no additional cost to the Owner. Use hand tamping for recompaction over underground utilities and trenches.

3.6 FIELD QUALITY CONTROL TESTING AND INSPECTION SERVICES

A. Soil Testing Service/Geo-Technical Engineer must inspect and approve density tests, retesting, and proof rolling of subgrades, as described in this section, before further construction work is performed thereon.

B. Perform compaction density testing on compacted fill and imported granular base course in accordance with ASTM D1556, ASTM D1557, ASTM D2922, and D3017.

C. In place density testing should be performed at a frequency of one (1) test per 500 square feet per lift in smaller open areas, one (1) test per 2,500 square feet per lift in larger open areas, and one (1) test per 25 feet per lift in confined areas and utility trenches.

D. When the test results indicate that insufficient compaction has been obtained in any layer, the Contractor shall take action to modify or alter the moisture content in the soil, to provide additional compaction and testing or otherwise to increase the in-place soil density. If the Contractor cannot obtain satisfactory compaction due to material properties, the Contractor shall remove the unsatisfactory material and replace with new material at no additional cost to the Owner.

E. Materials contaminated by mud, debris, organics, frost, and/or other deleterious materials shall be removed and replaced with uncontaminated specified material.

F. No fill or backfill shall be placed over an area or lift of fill that has not be tested and achieved satisfactory results.

G. Proof Rolling: On pavement subgrades, in cut areas only, unless otherwise directed by the Architect, the only testing required will be the proof rolling as described below:

1. Provide Soil Testing Service/Geo-Technical Engineer with 48-hour advance notification when subgrades are ready to proof roll.

2. Proof Roll the prepared pavement subgrade surface with fully loaded ten (10 c.y.) cubic yard earth moving truck or, in the opinion of the Architect/Geo-Technical Engineer, using a 5-ton smooth drum roller making at least 3 overlapping passes, in each of 2 perpendicular directions, on static mode at a speed of 1 to 4 feet/second. Check for unstable areas. Subgrades that rut, pump or deflect under the truck's tires may be judged unstable by the Architect/Geo-Technical Engineer. These areas may require further compaction or undercutting as directed by the Soil Testing Service/Geo-Technical Engineer.

3.7 GUARANTEE

A. Guarantee concrete slabs, pavements, trenches, utilities, structures, stairs, retaining walls, lawns, and plant materials free from settlement for a period of one (1) year from the date given on the certificate of substantial completion or final punch list when satisfactorily completed and accepted by the Architect, whichever is later.

B. Repair to proper grade and alignment any and all settlement of concrete slabs, pavements, trenches, utilities, structures, stairs, retaining walls, lawns, and plant materials adversely affected by settlement within one (1) year after date given on the certificate of substantial completion or final punch list when satisfactorily completed and accepted by the Architect, whichever is later, at no additional expense to the Owner. In damaged compacted areas, scarify the surface, re-shape, and compact to required density prior to further construction.

C. All repairs/corrections shall be completed to the satisfaction of the Owner within seven (7) days of written notice by the Owner.

3.8 CLEAN UP

During the contract and at intervals as directed by the Architect and as earthwork is completed, clear the site of surplus earth, large surface stones, debris, tools and equipment. Leave the site in a clean, safe, well draining, and neat condition.

END OF SECTION 312201

SECTION 312300 – STRUCTURAL EXCAVATION, BACKFILL, AND COMPACTION

1.0 PART 1 GENERAL

1.01 Related Work Specified Elsewhere - Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division 1 of these Specifications.

1.02 Description of Work - Work covered by this section shall include all labor, material, equipment, and services necessary to complete the job as shown or called for on Architectural and Structural Drawings. Also included, but not limited to, shall be:

A. Layout and install batter boards and grade stakes.
B. Excavation for building foundations, footings and retaining walls as shown on the Structural Drawings.
C. Bracing, shoring, and sheeting for protection of excavations.
D. Pumping water from excavations.
E. Hand trim footing excavation to maintain proper size of footing.
F. Backfill excavations and rough grade as indicated and required.
G. Supply, place, and compact slab base and pavement base.
H. Remove all excess excavated material from the site.

1.03 Quality Assurance

A. Job Safety: This is the sole responsibility of the Contractor. OSHA requirements shall be followed.

1.04 Submittals

A. Samples:
   1. Slab base material: 20 lbs.
   2. Furnish source location and current N.Y.S.D.O.T. acceptance number with above samples.
B. Product Data: Manufacturer's specifications and performance data for Filter Cloth if required on the drawings.

2.0 PART 2 PRODUCTS

2.01 Materials

A. Batter Boards: Shall be of new lumber with rigid supporting members.
B. Backfill Inside and Outside of the Building Area: Shall be clean, well graded, NYSDOT item 304-2.02 Type 2 or run of crush stone for the top 6" and NYSDOT item 304-2.02 Type 3 below 6" of fill required.
C. Granular Slab Base: Shall be clean, well graded, NYSDOT item 304-2.02 Type 2 or washed and crushed stone, well graded from 3/4" to 2" maximum size, except over footings 12" or less below finished slab on grade.

D. Lean Concrete Fill: Minimum compressive strength of 1,500 psi at twenty eight (28) days.
E. Shoring and Bracing: Provide materials for shoring and bracing, such as sheet

piling, uprights, stringers and cross-braces, in good serviceable condition. Use timbers that are sound and free of large or loose knots.

F. Material Definitions:

1. Satisfactory Soil Materials: Are defined as those complying with the American Association of State Highway Officials (AASHO). Designation M-145, soil classification Groups A-1, A-2-4, A-2-5, and A-3.
2. Unsatisfactory Soil Materials: Are defined as those described in AASHO M-145, soil classification Groups A-2-6, A-2-7, A-4, A-5, A-6, and A-7; also peat and other highly organic soils; and soil materials of any classifications that have a moisture content at the time of compaction beyond the range of 1% below and 3% above the optimum moisture content of the soil material, as determined by the Moisture Density Relations Test.
3. Cohesionless Soil Materials: Includes gravels, sand-gravel mixtures, sands, and gravelly sands. Moisture density relations of cohesionless soils, when plotted on graphs, will show straight lines or reverse-shaped moisture density curves.
4. Cohesive Soil Materials: Includes clayey and silty gravels, sand-clay mixtures, gravel-silt mixtures, clayey and silty sands, sand-silt mixtures, clays, silts, and very fine sands. Moisture density relations of compacted cohesive soils, when plotted on graphs, will show normal moisture density curves.

3.0 PART 3 EXECUTION

3.01 Layout, Lines, Levels, and Field Checks

A. The Contractor shall stake out and run levels for the building as indicated on the drawings. Erect batter boards and secure firmly against movement. Batter boards shall be protected against all hazards of damage until their use is no longer required and permission or direction is given by the Architect for their removal and disposal. Maintain carefully all bench marks, monuments, and other reference points.

B. Lines and Levels: Run from property monuments and benchmarks.

C. The Contractor shall verify field conditions such as topography, inverts, location of utilities, and property lines before proceeding with the work so that changes can be made, if necessary, to accommodate the plans to the site. Discrepancies discovered in the field shall be brought to the Architect's attention before proceeding with the work.

3.02 Grading

A. Grading surface of fill under building slabs. Grade the surface of compacted existing soil or fill under building slabs smooth and even, free of voids, compacted as specified, and to required elevation. Provide final grades within a tolerance of 1/4" when tested with a ten (10) foot straight-edge.

3.03 Excavating

A. Subsurface Information: Test borings and other exploratory operations may be

made by the Contractor at no additional cost to the Owner, provided such operations are acceptable to the Architect and the Owner.

B. Remove and dispose of material encountered to obtain required subgrade elevations, including pavement, obstructions visible on ground surface, underground structures, and utilities indicated to be removed.

C. Disposal: Transport excavated material offsite to legal disposal.

D. Bracing and Shoring: Provide bracing and shoring as required in excavations, to maintain sides and to protect structures from settlement. Slope sides of excavations over five (5) feet deep to the angle of repose of the material excavated; otherwise, shore, and brace where sloping is not possible either because of space restrictions or stability of material excavated. Maintain shoring and bracing in excavations regardless of the time period excavations will be open. Carry down shoring and bracing as the excavation progresses.

E. All shoring and bracing must be removed before completion of backfilling except where required for structural support of slope stability. The Contractor shall be responsible for the design, installation, and maintenance of such shoring or bracing required to accomplish the above purpose. The Contractor shall indemnify the Owner, the Architects, and the Consulting Engineers against any action arising from damage to existing structures or injury to persons resulting from the Contractor's actions or failure to act in carrying out the intent of this Specification.

F. Protections: Protect structures, utilities, sidewalks, pavements, and other facilities in areas of work. Barricade open excavations and provide warning lights from dusk to dawn each day.

G. Explosives: Use of explosives will not be permitted.

H. Existing Utilities: Locate by hand excavation and provide protection from damage. Cooperate with the Owner and utility companies for maintaining services. Do not break utility connections without providing temporary services, as acceptable to the Architect. Repair damages to existing utilities as directed by the utility company without additional cost to the Owner.

I. Extent of Excavations: Excavate for structures to elevations and dimensions shown, extending excavation a sufficient distance to permit placing and removal of other work and for inspection. Trim bottom to required lines and grades to provide solid base to receive concrete.

1. Footing bottoms shall be cleaned of loose materials, mud, and debris. Satisfactory bearing material loosened by construction operations or surface water shall be removed and replaced with lean concrete.
2. Footing bottoms below or within two (2) feet of ground water level shall be sealed with a minimum of a three (3) inch layer of lean concrete below the footing.
3. If unsatisfactory soil materials are encountered at design elevations, continue excavation to sound material.
4. Removal of materials beyond indicated subgrade elevations shall be filled with lean concrete, or corrected by extending the indicated bottom elevation of the footing to the lower elevation, as directed by the Engineer and with no additional cost to the Owner.

J. Notify the Soils Engineer when excavations to the contract depth are completed in order that assumed foundation bearing materials can be verified before footing concrete is placed.

K. Pumping Equipment: Furnish and operate sufficient pumping machinery to keep

all excavated parts free from water at all times. Pits shall be dug if necessary into which the excavation shall be drained. Care and proper precautions shall be taken in the use of pumps so that in no case will foundations already in place or existing foundations of adjacent structures be undermined or disturbed due to pumping.

L. Trimming: At excavation for footings, hand trim trench bottoms to firm, hard bearing. Use "blade" type bucket.

3.04 Backfilling

A. Backfill consists of placement of specified backfill material, in layers, in the excavations to the required subgrade elevations.
   1. Footings shall be backfilled to tops of footing immediately after removal of forms and any required concrete repairs.
   2. Backfill against walls shall not be started until required concrete repairs are made and portions of superstructure bracing the walls are in place, except if specifically approved by the Architect in writing.
   3. All backfill at exterior walls shall be pitched to drain surface water away from walls.

B. Slab Base: In all areas where floor slabs on earth occur, after installation and approval of all piping below floors, install fill as specified herein. The subgrade and fill shall be compacted and set to proper elevations with an instrument and shall be pitched to drains as directed.

3.05 Placement and Compaction

A. Place backfill material in layers not more than eight (8) inched in loose depth, compacting each layer to required maximum density. Test each layer with spot checks as required.

B. Compaction: Compact each layer of backfill material to 95% after proof rolling subgrade.

C. Moisture Level: Apply water to surface of subgrade or layers of soil material if required. Remove and replace, or scarify and air dry, soil materials that are too wet to permit compaction to specified density.

D. Equipment: Use power-driven hand tampers for compacting materials adjacent to structures, over footings, and within the building area.

E. Reconditioning Compacted Areas: Where complete compacted areas are disturbed by subsequent construction operations or adverse weather, scarify the surface, re-shape, and compact to the required density prior to further construction. Use hand tamping for recompaction over underground utilities.

3.06 Completion

A. On completion of the work as set out, the entire site shall be cleaned up and left free of all surplus earth, large stones, debris, tools and equipment, etc., and shall be left in a neat sightly condition to the satisfaction of the Owner.

END OF SECTION 312300

SECTION 312501 - EROSION, SEDIMENT AND POLLUTION CONTROL

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Provide erosion, sediment and pollution controls as shown on the drawings and as directed by the Architect to significantly reduce runoff on downstream and neighboring properties. This includes temporary control measures to mitigate land disruption by other Contractors during construction of this project.

B. Erosion, sediment and pollution control includes, but is not limited to, the following:

1. Storm structure protection
2. Silt fence
3. Temporary concrete washout facility
4. Permanent sodding
5. Construction site dust control
6. Spill prevention, reporting and documentation
7. Clean up

C. Provide materials, labor, equipment and services required to accomplish related work in accordance with the drawings and specifications.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 311201 - Site Preparation

B. Section 312201 - Site Earthwork

C. Section 329201 – Sodded Lawns

D. Section 334001 - Storm Drainage

1.3 REFERENCES

A. Spill Guidelines Manual (SGM) New York State Dept. of Environmental Conservation.

B. New York State Standards and Specifications for Erosion and Sediment Control, dated July 2016 or latest edition.

1.4 SUBMITTALS: (See Section 311201, 1.5)

A. Manufacturer's Data (MPD) are required for:

1. Storm Structure Protection
2. Silt Fence with Net Backing
3. Spill Response Equipment

B. Material Certificates (MC) showing content/mechanical analysis and Samples are required for:

1. Permanent Sodding: (See Section 329201)

C. Listing of emergency contract numbers. This list shall include the name of an Emergency Response Contractor that may be used in certain situations.

1.5 QUALITY ASSURANCE

A. Perform erosion, sediment and pollution control in compliance with applicable requirements of the New York Standards and Specifications Erosion and Sediment Control Manual, dated July 2016 (or latest edition) or other governing authorities having jurisdiction.

B. It is this Contractor's responsibility to prevent stormwater pollution from running offsite. All pollution control work related to the site contract shall be included in the Base Bid. All pollution control work related to other contracts shall be on a time and material basis and back-charged to the responsible party.

C. In the event of a chemical or hazardous spill or release, the individual(s) who caused the spill is responsible for prompt and proper clean-up. If the spill requires cleanup procedures beyond the means of the Contractor, an emergency spill cleanup Subcontractor shall be hired by the Contractor. They shall be utilized when the Contractor does not have the appropriate training, equipment or materials to cleanup the area safely and effectively. This shall be done at no additional cost to the Owner. Any testing and cleanup required post cleanup shall be provided by the Contractor at no additional cost to the Owner.

1.6 JOB CONDITIONS

A. Job conditions in Sections 311201, 312201, 329201 and 334001 apply.

B. Contractor will take all necessary precautions to avoid allowing dust generation that violates NYSDEC regulations and compromises compliance with governing authorities air monitoring plan.

1.7 INSPECTIONS AND MAINTENANCE

A. The Architect or qualified personnel of the Operator shall inspect disturbed areas of the construction site at least once per week. Special attention will be focused on areas not finally stabilized, structural control measures, point discharge (outlets) 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.

B. The Contractor shall provide timely maintenance of vegetation erosion and sediment control measures, and other protective measures, during construction. Corrective measures must be performed within one (1) calendar day of the Architect's or Operator's (Owner's) report. Failure by the Contractor to perform corrective work within this schedule automatically authorizes the Operator to hire others and backcharge this

Contractor. The Architect or Operator will send a letter or email correspondence one (1) calendar day before hiring others and backcharging this Contractor.

C. The Contractor shall conduct daily inspections of the equipment staging and maintenance, fueling, hazardous waste staging and waste storage areas to ensure that spill control measures are in place. Stock appropriate clean-up materials whenever changes occur in the types of chemicals used or stored on site.

D. The Operator (Owner) shall provide long-term maintenance of the storm water facilities after the site is finally stabilized.

1.8 SPILL PREVENTION, REPORTING AND DOCUMENTATION

A. To minimize the potential for discharge to the environment of oils, petroleum, or other hazardous substances, the following requirements shall apply:

1. All oil, petroleum, or hazardous materials stored or temporarily relocated on site during the construction process shall be stored in a way to provide protection from vehicular damage and to provide containment of leaks or spills. Temporary berms, dikes, storage basins, or similar methods shall be employed as appropriate on site.

2. Maintain file of Material Safety Data Sheets (MSDSs) or other references for recommended spill clean-up methods and materials.

3. Keep spill response equipment readily accessible.

B. In the event of a spill contact the Construction Manager, Owner (Operator), and Architect. The Contractor shall also notify all other Contractors working around the area of the spill.

C. If spilled material has entered any sanitary/storm sewer system then contact the municipality or agency with jurisdiction over the system, in addition to those listed in this section.

D. The contractor shall be responsible for the initiation of spill reporting and documentation procedures. All petroleum spills must be reported to NYSDEC Spill Hotline at 1-800-457-7362, less than two (2) hours following discovery. All petroleum spills must be reported to NYSDEC unless all of the following apply:

Criteria	Description
Quantity	Must be known to be less than 5 gallons.
Containment	Must be contained on an impervious surface or within an impervious structure. No access to the environment.
Control	Must be under control and not reach a drain or leave the impervious surface.
Cleanup	Must be cleaned-up within two (2) hours of occurrence.
Environment	Must not have already entered into soil or groundwater or onto surface water.

E. A release of a "reportable quantity"[1] or unknown amount of a hazardous substance must also be immediately reported to the NYSDEC Spill Hotline. Spills of reportable

quantities of chemicals or "harmful quantities"[2] of oil to navigable waters must be reported to the federal National Response Center, 1-800-424-8802 or 1-202-426-2675.

[1] *Reportable Quantity*: Refers to the quantity of a hazardous substance or oil that triggers reporting requirements under the Comprehensive Emergency Response, Compensation, and Liability Act (CERCLA) (USEPA, September 1992).

[2] *Harmful Quantity*: Includes discharges that violate applicable water quality standards, cause a film, sheen, or discoloration on a water surface or adjoining shoreline; or cause a sludge or emulsion to be deposited beneath the water surface or shoreline (40 CFR 110.3).

PART 2 - PRODUCTS

2.1 STORM STRUCTURE PROTECTION

A. Shall be a pre-manufactured cylindrical log 12" – 32" in diameter, composed of degradable geotextile mush tube filled with compost filter media to filter sediment and other pollutants. Filter socks may be filled after placement by blowing compost into the tube pneumatically or filled at a staging location and moved into its designated location. Both ends of the filter socks shall be secured to prevent opening.

B. The flat dimension of the sock shall be at least 1.5 times the nominal diameter of the sock.

C. Compost infill shall be a well decomposed (matured at least 3 months), weed-free, organic matter. Shall be aerobically composted, possess no objectionable odors, and contain less than 1% by dry weight, or manmade foreign matter.

D. All biosolids compost must meet NYS DEC's 6NYCRR Part 360 (Solid Waste Management Facilities) requirements.

E. When using compost filter socks adjacent to surface water, the compost should have a low nutrient value.

F. Wood stakes shall be a minimum of 2" x 2" in size. Shall be untreated fir, redwood, cedar or pine and shall be cut from sound timbers. Shall be straight and free of loose and unsound knots or other defects which would render them as unfit for the intended use. Metal stakes may not be used as an alternate. Tops of stakes shall not extend above the top of the fiber roll.

G. Standard of quality shall be: Diamond SOCK® pre-filled compost filter sock as manufactured by MKB Stormwater Innovation, 888-578-0777; or Architect Approved Equal

2.2 SILT FENCE

A. Shall be a woven polypropylene geotextile comprised of UV stabilized polypropylene slit film and 1.25" square, non pressure treated, pointed, hardwood posts and net mesh backing for additional support. Standard of quality for silt fence shall be IVI-3611MW as manufactured by Indian Valley Industries, Inc., www.iviindustries.com, (607) 729-5111, or Architect approved equal.

2.3 TEMPORARY CONCRETE WASHOUT FACILITY

A. Concrete washout facility to fully contain all concrete washout needs of the entire project and all contracts.

B. Concrete washout facility shall be temporary straw bales that are lined with a single sheet of a minimum of 10 mil polyethylene sheeting that extends over the entire basin to prevent escape of discharge. Place a secure, non-collapsing, non-water collecting cover over the concrete washout facility prior to inclement weather to prevent accumulation and overflow of precipitation.

C. Provide concrete washout to prevent discharge from concrete trucks or equipment cleaning to inlets, surface or groundwater.

D. Concrete washout facility shall be no closer than 50 feet from environmentally sensitive areas such as waterbodies, wetlands, and open drainage facilities and watercourses. Signs shall designate concrete washout facilities.

E. Ensure that the concrete washout facility complies with all Federal, State and local laws, rules, and regulations. Ensure that the concrete washout facility is in place before delivery of concrete to site.

F. Provide a sign identifying area as "Concrete Washout" acceptable to the Architect. Maintain throughout the project duration.

2.4 PERMANENT SODDING

Sodding shall be as specified in Section 329201.

2.5 SPILL RESPONSE EQUIPMENT

A. The following is a list of recommended spill control material. The contractor is responsible to have spill control and personnel protective equipment readily available for the materials being used. Acquire sufficient quantities and types of appropriate spill control materials needed to contain any spills that can be reasonably anticipated. The need for equipment to disperse, collect and contain spill control materials should be on site at all times.

1. Personal Protective Equipment
   a. Chemical Splash Goggles
   b. Gloves
   c. Boot Covers
   d. Tyvek Aprons or Suits

2. Absorption Materials
   a. Spill Pillows and Socks
   b. Absorbent Booms and Pads
   c. Dikes for use on rough surfaces
   d. Storm Structure Covers
   e. “Loose” Absorbents

3. Tools
   a. Shovel, Broom, Brush
   b. Disposal Bags
   c. Sealing Tape
   d. Hazardous Waste Stickers
   e. "Danger" and "Keep Away" Signs
   f. Five gallon pails or 20 gallon drums with polyethylene liners

B. Basis of Design shall be provided by: 3M, 888-364-3577; New Pig Corporation, 800-468-4647; SpillKits911, 800-474-5911; Dawg, Inc., 800-935-3294; or Architect approved equal.

C. Place spill response equipment in a readily assessable location within or immediately adjacent to the project site.

PART 3 - EXECUTION

3.1 REQUIREMENTS

A. Between the Pre-Construction Meeting and starting site work, the Contractor shall:

1. Review inspection and maintenance procedures.
2. Designate specific Owner and Contractor personnel responsible for daily inspection and maintenance.

3.2 GENERAL EROSION CONTROL

A. Install initial construction erosion control features, as indicated on drawings and specifications or as directed by the Architect, prior to topsoil stripping, earthwork, and removal of existing vegetation. Keep the disturbance to a minimum and shall not exceed five (5) acres, unless directed by the Architect. Install other features as described in the sequence of erosion, sediment and pollution control on the drawings.

B. Start permanent seeding within seven (7) calendar days of rough grading. When this is not possible, provide temporary seeding of 100% perennial rye grass at the rate of six pounds (6#) seed per one thousand (1,000 sf) 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 permanent lawn stabilization.

C. Until a disturbed area is stabilized, trap runoff sediment by the use of sediment debris basins, diversion swales, sediment traps, or other methods acceptable to the Architect and governing authorities. Provide temporary dry mulch (straw) to stabilize exposed soils as directed by the Architect.

D. Provide erosion controls on slopes and swales traversing, bordering, or leaving the site. Limit the water flow to a nonerosive velocity.

E. Do not store fill materials within one hundred (100) feet of the banks of any streams or waterbodies, intermittent or perennial.

F. Inspect erosion and sediment control measures immediately after each rainfall and at least daily during prolonged rainfall. Make required repairs immediately.

G. Remove sediment deposits when they reach approximately one-half of the height of the barrier. Dispose sediment in a manner that does not result in additional erosion or pollution.

H. Provide prompt (weekly) removal and disposal of rubbish and debris in accordance with the governing authorities, Owner policies, and good housekeeping measures.

3.3 MUNICIPAL SEWER, SWALES AND WETLAND EROSION CONTROL

Control erosion, siltation and pollution to municipal sewers, swales and wetlands by taking appropriate measures such as, but not limited to, the following:

A. Do not disturb the bed and banks of waterbodies unless specifically shown on drawings. When bed and bank work is shown, obtain permits and proceed with work creating the minimum disturbance necessary to complete the project.

B. Prevent petroleum products and excessive amounts of silt, clay, and muck from entering municipal sewers, waters, swales or wetlands of New York State during construction.

C. Prevent fresh concrete, concrete leachate, and washings from equipment and trucks, from entering municipal sewers, waters, swales or wetlands of New York State during construction.

D. Place silt fence to control erosion at the downslope edge of disturbed areas. This barrier to sediments is to be put in place before disturbance of the ground occurs and is to be maintained in good condition until disturbed land is heavily vegetated or otherwise permanently stabilized.

E. Seed areas of soil disturbance resulting from this project with appropriate perennial grass seed and mulched with straw within seven (7) calendar days as described in general erosion control. Mulch shall be maintained until a suitable vegetative ground cover is established and as directed by the Architect.

3.4 CONSTRUCTION SITE DUST CONTROL

A. The Contractor shall prevent surface and air movement of dust from disturbed soil surfaces that may cause off-site damage, health hazards, and traffic safety issues.

B. Dust control applies to construction roads, access points, other disturbed areas and stockpiles subject to surface dust movement and dust blowing.

C. Contractor may use any number and combination of dust control methods, as approved by the Architect. They include:
   1. Applying water to haul roads
   2. Restricting vehicle speeds to 10 mph
   3. Hauling materials in properly tarpped or watertight containers.
   4. Covering stockpiles and materials

5. Wetting equipment and work area
6. Mulching
7. Spray adhesives and polymer additives (MSDS sheets required)
8. Barriers and wind breaks

D. Contractor is responsible for any cleanup and site restoration associated with dust control measures, dust pollution on or off the project site property at no additional cost to the Owner.

3.5 STORM STRUCTURE PROTECTION

A. Install fiber rolls as detailed around drainage structures and where shown on the plans to protect site elements from silt and sediment.

B. Filter socks shall be anchored in earth with wooden stakes driven a minimum of 12” into the soil on 4-foot centers on the centerline of the sock. On uneven terrain, effective ground contact can be enhanced by the placement of a fillet of filter media on the disturbed area side of the compost sock.

C. Wrapping the storm structure grate with fabric is NOT acceptable, however straw bales may be used.

D. Upon stabilization of the area contributary to the sock, stakes shall be removed. The sock may be left in place and vegetated or removed in accordance with the SWPPP. For removal, the mesh can be cut, and the compost spread as an additional mulch to act as a soil supplement.

3.6 SILT FENCE

A. Locate as shown on drawings 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. 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 (2) stakes. Set stakes simultaneously. Overlap by minimum six (6") inches, fold, and staple to prevent sediment bypass.

E. Attach silt fence securely to stakes spaced no more than eight (8' o.c.) feet on center. Secure fence fabric to stake with minimum three one (1") inch staples.

F. Toward the end of the project, when site is stabilized and as directed by the Architect, remove silt fence and correct lawn area around removal to a smooth, neat, well-draining condition.

3.7 TEMPORARY CONCRETE WASHOUT FACILITY

A. Install per detail in a location as approved by the Owner. Provide a stable surface, easily accessible by concrete trucks.

B. A sign shall be installed adjacent to each washout facility to inform concrete equipment operations to utilize the proper facilities. The sign shall be installed as detailed and maintained throughout the project.

C. Temporary concrete washout facility shall be constructed and maintained in sufficient quantity and size to contain all liquids and concrete waste generated by washout operations for the entire project and by all Contracts.

D. Perform washout of concrete mixers, delivery trucks, and other delivery systems in designated areas only.

E. Wash concrete only from mixer chutes into approved concrete washout facility.

F. Plastic lining material shall be a minimum of 10-mil polyethylene sheeting and shall be free of holes, tears or other defects that compromise the impermeability of the material. Liner seams shall be installed in accordance with manufacturers' recommendations.

G. Contents of the concrete washout facility shall not exceed 50% capacity of the facility. At or before 50% capacity is reached, discontinue pouring concrete until the facility is cleaned out. Remove hardened concrete and properly dispose off site. Allow slurry to evaporate or remove from site and dispose off site. Immediately replace the liner if it gets damaged.

H. Remove concrete washout facility when it is no longer needed as directed by the Architect.

3.8 PERMANENT SODDING

A. Install as described in Section 329201.

3.9 SPILL RESPONSE EQUIPMENT

Use per manufacturer’s recommendations and as directed by the NYSDEC, or other governing agencies.

3.10 CLEAN UP

A. During the contract and at intervals as directed by the Architect 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 and detention basins: 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 312501

SECTION 321201 - ASPHALT PAVING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. The extent of asphalt paving is shown on the drawings.

B. Asphalt Paving work includes, but is not limited to, the following:

1. Soil Stabilization Fabric
2. Granular Base Course
3. Asphaltic Concrete
4. Bituminous Tack Coat
5. Painted Lines, Traffic and Recreational Markings
6. Asphalt Sealer
7. Hot Pour Crack Sealing and Filling
8. Field Quality Control
9. Clean up

C. Provide all materials, labor, equipment and services required to accomplish related work in accordance with the drawings and specifications.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 311201 - Site Preparation

B. Section 312201 - Site Earthwork

C. Section 334001 - Storm Drainage

1.3 REFERENCES

A. The latest editions of the following Standards, as referenced herein, shall be applicable:

1. New York State Department of Transportation Standard Specifications, Section 402 - “Hot Mix Asphalt (HMA) Pavements" and 407 - "Bituminous Tack Coat"
2. “Standard Specifications for Highway Materials and Methods of Sampling and Testing, American Association of State Highway and Transportation Officials (AASHTO).”
3. American Sports Builders Association (ASBA) Asphalt Guidelines, latest edition

B. The following reference standards shall apply for Testing and Inspection:

1. ASTM D1074: Standard Test Method for Compressive Strength of Bituminous Mixtures
2. ASTM D1188: Standard Test Method for Bulk Specific Gravity and Density of Compacted Mixtures Using Paraffin-Coated Specimens.
3. ASTM D2041: Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures

4. ASTM D2726: Standard Test Method for Bulk Specific Gravity and Density of Non-absorptive Compacted Bituminous Mixtures
5. ASTM D2950: Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Methods
6. ASTM D3203: Standard Test Method for Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures
7. ASTM D3549: Standard Test Methods for Thickness or Height of Compacted Bituminous Paving Mixture Specimens
8. NYSDOT Materials Method 28 Friction Aggregate Control and Test Procedures

C. The following reference standards shall apply for pavement markings:

1. ASTM D562, D711, D1475, D1640, D2369, D3723, D3960.
2. DOT Code of Federal Regulations, Hazardous Materials and Regulations Board, Reference 49CFR, ICC Regulations
3. Federal Specification TT-P-115E, Type III (Type I if V.O.C. compliance)

D. Additional testing required, only if directed in writing by Architect, due to asphalt installation and material issues:

1. ASTM C295: Standard Guide for Petrographic Examination of Aggregate
2. ASTM D1560: Standard Test Methods for Resistance to Deformation and Cohesion of Bituminous Mixtures by Means of Hveem Apparatus
3. ASTM D4125: Standard Test Methods for Asphalt Content of Bituminous Mixtures by the Nuclear Method
4. ASTM D5444: Standard Test Method for Mechanical Size Analysis of Extracted Aggregate
5. ASTM D6307: Standard Test Method for Asphalt Content of Hot-Mix Asphalt by Ignition Method
6. ASTM D6931: Standard Test Method for Indirect Tensile (IDT) Strength of Asphalt Mixtures
7. ASTM D7312: Standard Test Method for Determining the Pavement Shear Strain and Complex Shear Modulus of Asphalt Mixtures Using the Superpave Shear Tester

1.4 SUBMITTALS

A. Provide Paving Contractor experience requirements, as outlined in "Quality Assurance" of this specification section.

B. Provide Asphalt Producer Vendor Certificate and proof of quality control monitoring as outlined in "Quality Assurance" of this specification section.

C. Provide material certificates showing content/mechanical analysis for the following:

1. Asphaltic Concrete Mix Design with Authorization Signature:

a. Type/name of mix (less than 24 months old)
b. All aggregates gradations and quality measurements
c. Plot (0.45 power graph) of the final aggregate blend

d. Bulk (dry) specific gravity of all aggregates and final aggregate blend (Gsb) including worksheets for natural (virgin) as well as reclaimed asphalt pavement (RAP)
e. Grade of asphalt binder (PG) being used
f. Optimum percent asphalt binder (Pb)
g. Mix air voids at optimum (Va)
h. Bulk specific gravity of mix at optimum (Gmb)
i. Theoretical maximum specific gravity of mix at optimum
j. Voids in the Mineral Aggregate (VMA) and Void Filled with Asphalt (VFA)
k. Dust to total asphalt content (AC) ratio
l. All design data and associated design curves

2. Bituminous Tack Coat

D. Provide Manufacturer's Product Data (MPD) for the following:

1. Soil Stabilization Fabric
2. Painted Lines, Traffic and Recreational Markings
3. Asphalt Sealer
4. Hot Pour Crack Sealing and Filling

E. Provide shop drawings for the following:

1. Painted Lines, Traffic and Recreational Markings: Shop drawings indicating sizes, shapes, patterns, and colors of markings, including manufacturers and types of paint.
2. Owner to approve all paint colors prior to installation.

F. Submit Asphalt Placement Work Plan, indicating paving pass widths, paving directions, site access, and timing/coordination of any site equipment installation (posts, boxes, fencing, etc.) indicated in 3.3 of this specification section. Supply Owner with yield calculations for all asphalt paving products and materials used on the project as part of the work plan.

G. Field Quality Control test reports as indicated in this specification section.

1.5 QUALITY ASSURANCE

A. Paving Contractor Experience Requirements:

1. General Paving: Contractor shall have the experience of at least five (5) years in business. Paving superintendent has a minimum of three (3) years' experience as a paving crew operating foreman.

B. Asphalt Testing and Inspection Services:

1. The Owner will employ and pay for the services of an Independent Testing Agency to provide testing and inspections of asphalt pavements.

2. The services and the information provided by the Testing Agency are provided for the sole benefit of the Owner. The information is provided to the Contractor for the sole purpose of being aware of what is being reported.

3. The Contractor is solely responsible for assuring the work complies with the Contract Documents in all respects and may not rely on the testing agency for this or any other assurances. The Testing Agency and their representatives are not authorized to revoke, alter, relax, enlarge, or release any of the requirements of the Contract Documents, approve or accept any portion of the work, perform or excuse any duties of the Contractor, or be involved in the scheduling of any work.

4. Asphalt paving materials and operations shall be tested and inspected as the work progresses. Failure by the Testing Agency to detect any defective work or material shall not in any way prevent later rejection (when such defect is discovered) nor shall it obligate the Owner for final acceptance.

C. Asphalt producer shall monitor production according to the procedures of NYSDOT Material Method 28 Friction Aggregate Control and Test Procedures. Asphalt producer shall be a New York State approved/certified HMA (Hot Mix Asphalt) manufacturing facility.

D. Calibrated equipment and qualified personnel must be always accessible during the construction of the HMA.

1.6 JOB CONDITIONS

A. Job conditions in Section 312201 apply.

B. Atmospheric conditions for applying courses:

1. Hot mix asphalt shall generally arrive on the project site between 270°-300° F. (per asphalt producer recommendations).
2. Place asphalt concrete wearing course or bituminous surface treatment only when atmospheric temperature is above 50 degrees F. and rising, and when asphalt binder course is thoroughly dry.
3. Place binder course only when air temperature is above 45 degrees F. and rising and when asphalt base course or granular stone base course is thoroughly dry.

C. Grade Control: Establish and maintain required lines and elevations.

D. Codes and Standards: Perform the work in compliance with applicable requirements of governing authorities having jurisdiction. Obtain and pay for permits required by local authorities.

E. Construction Review and Testing: Notify and coordinate with the Independent Testing Agency and Architect when the subgrade is shaped and ready for proof rolling. Also, when the granular base course is fully installed, compacted and ready for density testing. Protect subgrade and subbase at all times.

F. When staging or scheduling delays occur and wearing course cannot be installed directly after binder course installation before winter, provide temporary asphalt transition ramp/collar around drainage structures in paved areas and at handicap ramps to prevent damage by snow plow. Remove prior to installation of wearing course. Power wash surface and apply asphalt tack coat, as specified, prior to wearing course installation, at no additional cost to the Owner.

1.7 DELIVERY, STORAGE, AND PROTECTION

A. Deliver all materials to the job site with all labels intact and legible at time of installation.

B. Store materials off ground under cover. Protect from damage or deterioration.

C. Handle materials to prevent damage to surface, edges, ends and factory applied finishes of items. Damaged material shall be rejected and replaced.

PART 2 - PRODUCTS

2.1 SOIL STABILIZATION FABRIC

A. Shall be a heavy duty, commercially manufactured woven polypropylene geotextile. Standard of quality shall be Mirafi 500X, manufactured by TenCate or Architect approved equal.

2.2 GRANULAR BASE COURSE AND GRAVEL PAVEMENT

A. Shall be as specified in Section 312201.

B. The graded and designed granular base below all new Asphaltic Concrete Pavements shall be constructed, tested, and prepared in accordance with Section 312201 - Site Earthwork of the Contract Documents.

2.3 ASPHALTIC CONCRETE

A.

Pavement Types	Percent Asphalt*
37.5mm Type 1 Base Course	4.8% Asphalt
19.0mm Type 3 Binder Course	4.8% Asphalt
9.5mm Type 7 Top Course	6.3% Asphalt

* Percentage of Asphalt is approximate and shall be based off actual project submittals provided by the Asphalt Producer.

B. Hot Mix Asphalt Top Course: Pavement shall meet the minimum requirements for 9.5 mm (Type 7) SUPERPAVE Hot Mix Asphalt Top Course (75 gyrations), with a PG 64-22 Binder as specified in Section 404, of the current NYSDOT Standard Specifications, with the exception that the maximum proportion of Recycled Asphalt Pavement (RAP) to virgin aggregates shall not exceed 20% of the total mix.

C. Hot Mix Asphalt Binder Course: Pavement shall meet the minimum requirements of 19.0mm SUPERPAVE Hot Mix Asphalt Binder Course (75 gyrations), with a PG 64-22

Binder, as specified in Section 404, of the current NYSDOT Standard Specifications, with the exception that the maximum proportion of Recycled Asphalt Pavement (RAP) to virgin aggregates shall not exceed 20% of the total mix.

D. Hot Mix Asphalt Base Course: Pavement shall meet the minimum requirements of 37.5mm SUPERPAVE Hot Mix Asphalt Base Course (75 gyrations), with a PG 64-22 Binder, as specified in Section 402, of the current NYSDOT Standard Specifications, with the exception that the maximum proportion of Recycled Asphalt Pavement (RAP) to virgin aggregates shall not exceed 30% of the total mix.

E. The coarse aggregate used in HMA shall be sound, angular crushed stone (crushed or rounded gravel is not acceptable). The fine aggregate shall be well graded, moderately sharp to sharp (angular) sands.

2.4 BITUMINOUS TACK COAT

A. Material shall consist of an asphalt emulsion, Grade RS-1h, and shall meet the minimum requirements of Section 407, of the current NYSDOT Standard Specifications. Bituminous Tack Coat shall be installed over all new and existing concrete and asphalt pavements and structures prior to the installation of new Hot Mix Asphalt materials. The following application rates shall apply:

1.	New Hot Mix Asphalt	0.05-0.07 gal/sy
2.	Milled Surfaces of Existing Asphalt	0.10-0.15 gal/sy
3.	Abutting Vertical Edges (drainage structures, appurtenances)	0.05-0.07 gal/sy
4.	All Styles of Curbs and Gutters	0.05-0.07 gal/sy
5.	Delayed asphalt installation of HMA Courses	0.10-0.15 gal/sy

2.5 PAINTED LINES, TRAFFIC AND RECREATIONAL MARKINGS

A. The extent of the pavement markings shall match the extent, location and composition of pavement markings existing at the site prior to start of work where applicable.

B. The work includes, but is not limited to the following: parking stall divider lines, wheelchair legends, “STOP” legends, “NO PARKING” legends, pick-up zone, striping and legends, directional arrow legends, diagonal striping, center line striping, fire lane striping, student area line striping, and other recreational pavement markings as may be shown on the plans.

C. Provide ready-mixed, one component waterborne traffic line paint. Standard of quality shall be: Pro-Park® Waterborne Traffic Marking Paint B-97 Series as distributed through Sherwin-Williams, 800-474-3794; or Architect approved equal.

1. Colors (as approved by the Owner in writing):

a.	Yellow:	1 Gallon & 5 Gallon, Product Number B97YD2467
b.	White:	1 Gallon & 5 Gallon, Product Number B97WD2434
c.	Blue:	1 Gallon & 5 Gallon, Product Number B97LD2022
d.	Black:	1 Gallon & 5 Gallon, Product Number B97BD2021

2. Paints shall contain all necessary co-solvents, dispersants, wetting agents, preservatives and all other additives, so that paint shall retain viscosity. Halogenated solvents and glass beads shall not be permitted.

3. Volatile Organic Compound (VOC) content shall not exceed 250 grams maximum per liter of paint as determined in accordance with ASTM D 3960 test, excluding water and exempt solvents.

5. Provide basketball lines, four square lines and hopscotch lines as detailed. Verify final locations and colors with Owner prior to installation. Provide an approximate 4,000 square foot area of recreational play markings in standard colors in style and location as directed by the Owner. Standard of quality shall be Everline Coatings, Fit and Fun Playscapes, Pavement Solutions or Architect/Owner approved equal.

2.6 ASPHALT SEALER

A. Product Description: A mineral filled asphalt emulsion pavement sealer fortified with special surfactants to promote superior adhesion and durability. Select aggregate is job-mixed to produce a slip-resistant coating.

B. Technical Data: Meeting the requirements of ASTM D 6937, ASTM D 6930, and ASTM D 2172 for asphalt based emulsion pavement sealer.

C. Environmental Considerations: Shall contain no asbestos. Environmentally friendly asphalt based pavement sealer containing less than fifty (50) grams per liter volatile organic content (VOC).

D. Physical Properties: The following material requirements when tested in accordance with ASTM D 5, ASTM D 113, ASTM D 36, ASTM D 93, ASTM D 4060, and ASTM D 2939 procedures.

E. Standard of quality: Masterseal Concentrate Asphalt Based Pavement Sealer as manufactured by Seal Master 800-395-7325, www.sealmaster.net or Architect approved equal.

F. Additive: Is a water based copolymer latex emulsion. Meeting the performance requirements of ASTM D 4866 specification for latex additive used in asphalt based emulsion pavement sealer. Standard of quality shall be Top Tuff Pavement Sealer Additive as manufactured by Thorworks Industries, Inc., 800-395-7325, www.thorworks.com.

G. Sand shall be thoroughly clean, 100% passing 40 to 70 mesh, AFS rating.

2.7 HOT POUR CRACK SEALING AND FILLING

A. Single component, hot applied asphalt crack and joint sealant capable of withstanding temperatures of up to 450° without experiencing polymer degradation.

B. Shall be supplied in solid blocks comprised of heat stabilized polymers and asphalt.

C. Meeting the following material requirements when tested in accordance with ASTM D5329. (see chart below)

Chemical & Physical Analysis

Recommended Application Temperature	350-400°F
Maximum Heating Temperature	450°F
Cone Penetration at 25°C	50 max.
Flow at 60°C, mm	0.
Softening point	200°F Min.
Flexibility 0°F	(1" Mandrel)-Pass
Specific Gravity	1.17
Asphalt Compatibility	Passes

D. Standard or quality shall be Crack Master Supreme as manufactured by Thorworks Industries, Inc., 800-395-7325, www.thorworks.com or approved equal.

PART 3 - EXECUTION

3.1 PREPARE SURFACE

A. Prior to commencement of asphalt paving, all excavations, drainage, utilities, backfilling, fencing, bollards, storm structures, curbing installations, adjustments, proof-rolling and density test procedures shall be complete to the satisfaction of the Architect.

B. Prior to commencement of tack coat and asphalt paving within pavement milled areas, as shown on the plans, all cracks and joints in the milled pavement surface shall be prepared and filled in accordance with the project specifications. Any oil or grease spots shall be scraped and treated to prevent bleeding through the tack coat.

C. Saw cut, using straight and true lines, all existing asphalt pavements to remain in place with straight, neat edge for abutting against proposed asphalt pavement.

D. Provide and confirm field quality control as described in Section 312201 for pavement subgrade and granular base course stone.

3.2 CONSTRUCT PAVEMENT GRANULAR BASE COURSE

A. General: Consists of placing granular base course material, in layers of specified thickness, over prepared subgrade and fabric to support a pavement course.

B. Grade Control: Provide engineering layout per Section 312201 and grade stakes. During construction, protect grade stakes; maintain lines and grades including crown and cross-slope of each course.

C. Install soil stabilization fabric after subgrade has been acceptably compacted and proof rolled. Install soil stabilization fabric as recommended by the manufacturer AND;

1. Lay fabric in direction of construction traffic.

2. Overlap fabric side to side and end to end a minimum of two (2') feet.

3. Establish reasonable compaction and rut stability before using heavy or vibratory compaction equipment.

D. Placing:

1. Place granular base material over soil stabilization fabric, on prepared subgrade in layers of uniform thickness, conforming to the asphalt pavement details on the drawings.

2. Place granular base material in a maximum of six (6) inch layers and compact with a vibratory or 10 ton smooth wheeled roller.

E. Provide density testing as described in Section 312201.

F. Surface Smoothness: Test finished surface for smoothness. Surface will not be acceptable when it deviates more than 3/8" measured by a 10 foot straightedge, in any direction.

G. The finished grade of the granular base course shall be verified to ensure that the final finished product of the bituminous concrete pavement surface will be installed to the lines and grades of the existing pavements and proposed elevations surveyed by the Contractor prior to the start of the paving work.

3.3 PLACE ASPHALT MIX

A. General:

1. The Contractor shall submit a paving plan, indicating intended direction of paving, number of pulls, etc. for approval prior to the start of paving operations.

2. Joints: Saw cut vertical straight, neat edges for joints required. Joints shall be sharp and clean, conforming to shapes drawn on drawings. Ragged joints will not be accepted.

3. Mill two (2') feet into surface of adjacent asphalt so joints do not line up or "stack".

4. Place bituminous tack coat to all surfaces as indicated in this specification. When pavement surface temperature is above or below the 75-130 degrees F. range, the grade of asphalt emulsion must be modified according to NYSDOT standards. Tack coat shall not be applied to a wet surface or when the pavement surface temperature is below 45 degrees F.

5. Place asphalt on approved prepared surface, spread and strike-off.

6. Spread mixture at minimum temperature of 225-240 degrees F. Place inaccessible and small areas by hand. Hand work shall be minimized to ensure the best possible finished surface.

7. Place each course to required grade, cross-section, and compacted thickness.

8. Paving operations shall not be scheduled when ample time does not exist to place, compact, and finish roll the hot mix asphalt during daylight hours and prior to rainfall.

B. Pavement Placing: Shall be installed in accordance with Section 402-"Hot Mix Asphalt (HMA) Pavements", of the current NYSDOT Standard Specifications.

C. Paving Equipment:

1. Must be capable of placing, spreading and finishing courses of HMA to the specified thickness.

2. HMA shall be free of marks, segregation and be placed to the required uniform elevation with a smooth texture not showing tearing, shoving, or gouging.

3. Auger extensions are required while pavers are extended beyond the basic screed width.

4. Paving equipment shall be self-propelled and capable of maintaining the line and grade shown on the plans with suitable electronic equipment. The screed shall be straight and true with no bow and utilizing a vibratory screed. Paving equipment should have fully functional screed heaters and joint preheaters.

D. Asphaltic Concrete shall be installed as follows:

1. Heavy Duty Asphalt Pavement: Installed in three (3) lifts consisting of a 37.5mm SUPERPAVE Hot Mix Asphalt Base Course overlain by 19.0mm SUPERPAVE Hot Mix Asphalt Binder Course overlain by 9.5mm SUPERPAVE Hot Mix Asphalt Top.

E. Place in strips not less than ten (10') feet wide, unless otherwise acceptable. In placing each succeeding pass after the placement of the initial pass, the screed of the paver shall be set such that it overlaps the preceding pass by 6" and be sufficiently high such that when compacted, a smooth joint is produced. Prior to pinching the joint, the excess material shall be pushed onto the edge of the new pass with a lute. Excess material shall be removed.

F. After first lift has been placed and rolled, place succeeding lifts and extend rolling to overlap previous lifts. Where possible, top course shall be placed at right angles to binder course and in the direction that the drainage flows. Where this is impractical, offset joints of the two courses by a minimum of two (2') feet so upper and lower joints do not align.

3.4 ROLL ASPHALT MIX

A. General:

1. Rollers shall conform to the manufacturer's specifications for all ballasting. At least one vibratory roller shall be required for each project, with two rollers required as a minimum. (Three rollers shall be required when tonnage is greater than 300 tons/day.)

2. Rollers shall be of a good condition and capable of compacting the HMA to the minimum in-place density required by this specification. Compact asphalt with a nominal 10 ton steel wheel roller or pneumatic rubber tired roller. Compact mixture with hot hand tampers or vibrating plate compactors in areas inaccessible to rollers.

3. Begin rolling when mixture will bear roller weight without obvious or excessive displacement.

B. Finish Rolling: Each lift of the Asphaltic Concrete Pavement shall be mechanically rolled and compacted to the finished thicknesses specified in the Contract Documents. The pavements shall be compacted to a minimum of 94%-97% (95%-102% at longitudinal joints) of the materials theoretical density as determined by AASHTO Method T 209 and an air void percentage of 5%-6% maximum.

C. Patching: Remove and replace paving areas mixed with foreign materials, dirt, and defective areas. Cut-out such areas and fill with fresh, hot asphalt concrete. Compact by rolling to maximum surface density and smoothness.

D. Joints:

1. The Contractor shall sequence the installation and orientation of all Asphaltic Concrete Pavements such that the minimum numbers of longitudinal and transverse joints are produced and in accordance with the approved Asphalt Placement Work Plan.

2. Neat, straight butt joints between successive passes. Offset joints a minimum of six (6") inches between lifts of asphalt.

3. When repairs or staging of work occurs, make neat vertical saw cut between old and new work to create butt joint. Heat joint prior to pouring. Cold joints are <u>not</u> acceptable.

4. Apply bituminous tack coat to all surfaces and rates indicated under "Bituminous Tack Coat" of this specification section. Tack coat shall not be required on abutting vertical edges for pavements placed in the same day.

5. Minimize construction, longitudinal, and transverse joints left open for an extended period of time.

6. Construct longitudinal joints by paving in a hot fashion with a temperature of not less than 220°F to ensure maximum performance and adhesion.

7. Compact all joints to provide for a neat, uniform and tightly bonded joint that will meet both surface tolerances and density requirements of this specification.

8. Cut straight and true (vertical construction or transverse joints if the material has cooled to less than 220°F prior to the placement of the next pass to ensure the best performing joint possible.

E. Edges: Roll at 45 degrees as detailed, creating clean edge conforming to shapes indicated on the drawings. Ragged edges will not be accepted. Return and saw cut ragged edges at no additional cost to the Owner as directed by the Architect.

F. The final finished grades of the new Bituminous Concrete Pavements must be smooth and true to the contours and shall be installed to the lines and grades of the site prior to start of construction. The final finished grades shall match adjacent pavement surfaces and concrete slabs, aprons, and doorways.

G. Construction Delays (over 48 hours): When placement of the wearing course over the binder course is delayed over 48 hours, thoroughly clean existing surface of dirt, oil and other debris by pressure washing and sweeping. Place bituminous tack coat as specified in this section.

3.5 ASPHALT TOLERANCES

A. Thickness and Density: Compact each asphalt course to produce the thickness indicated on the drawings within the following tolerances:

1. Base Course: Plus or minus 1/2-inch
2. Binder Course: Plus or minus 1/4-inch
3. Wearing Course: Plus or minus 1/8-inch

B. Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. For Asphalt Concrete:

Base Course Surface:	3/8"
Binder Course Surface:	1/4"
Wearing Course Surface:	1/8"

C. Asphalt Cores: Shall be provided as indicated under "Field Quality Control" of this specification.

3.6 FIELD QUALITY CONTROL

A. The Owner’s Testing Agency shall provide the following in the daily report at a minimum:

1. Verify the following for the asphalt mix design prior to asphalt placement:

   a. The asphalt mix design has been approved.
   b. The asphalt mix design specifies the minimum relative compaction and the methods required to determine maximum density.

2. Verify the asphalt subgrade has been acceptably proof-rolled. (See Section 312201.)

3. Inspect /test aggregate base course material for in-place density (95%) and thickness. Test materials for gradation classification, and physical properties. (See Section 312201.)

4. Inspect/test asphalt wearing course material for compaction during placement and conduct thickness measurements during lay-down. Take temperature of the asphalt mixture and compare actual temperature with the approved asphalt mixture design range. As a minimum, perform the following inspection/tests:

   a. Collect trip tickets from trucks delivered to the site and verify correct mix design being used for the project.
   b. Temperature tests: one per truck.
   c. Lay down thickness (uncompacted): one per strip or 500 square feet minimum
   d. Verify equipment rolling pattern and passes to ensure proper compaction: one per day
   e. Density test (daily lab density): one test per 5000 square feet minimum
   f. Hot mix samples (laboratory testing for density per ASTM D1188): one per day
   g. Thickness per ASTM D3549 and density samples per ASTM D2950 by a properly calibrated nuclear asphalt testing device. If there is a disagreement between tests done by ASTM D2950 and ASTM D1188, the values done by ASTM D1188 will govern: one test per 20,000 square feet (surface lift), one test per 10,000 square feet (base lift)
   h. Air voids per ASTM D3203 or D2726: one test per 5000 square feet minimum
   i. Verify compaction at the joints and seams. The completed paved surface to be true to grade and cross section. Verify smoothness by using an unleveled 10 foot straightedge and ensuring no gap at any point between straightedge and pavement exceeds surface smoothness requirements above except at interception or at changes of grade.
   j. The screed/lay down thickness tolerance shall be between 1/8 to 3/16 inches greater than the required asphalt minimum layer requirement. When screed depth is set for the exact thickness as specified, immediately notify the Owner's Representative and Contractor that the installed asphalt thickness may be deficient to achieve the specified minimum thickness. Identify areas of non-complying thickness and attach a drawing identifying the areas to the daily field report.
   k. Immediately notify the Owner's Representative and Contractor when paving is being conducted in cold weather and asphalt temperatures are below or above the design mix range.
   l. Check the surface grades and drainage patterns. Identify on a drawing all paved areas that are holding water after asphalt placement and notify the Owner's Representative and Contractor. Small ponding areas (bird baths) larger than two (2') feet in any dimension are not acceptable. When this test proves that surface conditions are not acceptable, the Contractor will be responsible for correcting the problem areas. Install a one (1") inch shim coat of wearing course material, or other means acceptable to the Architect.
   m. Verify tack coat and edge coat have been applied at the proper rate.

5. Asphalt Cores: Shall be as directed by the Architect.

   a. Prior to final acceptance of the asphalt and before lining or other surface materials (resilient track surfacing, etc.) are placed, the Owner's Testing Agency shall core 3" diameter areas of the asphalt surfacing where directed by the Architect. Consistency, density, thickness, and tensile strength per ASTM D6931 will be evaluated.
   b. Patch core areas as directed by the Architect to match adjacent density, texture and thickness.
   c. Coordinate day to day scheduling with the Testing Agency.
   d. If cores vary significantly from the contract requirements, additional cores will be performed by the Testing Agency as directed by the Architect. Once the overall general quality is determined, provide remedial work as directed by the Architect to achieve the quality and consistence as specified.

B. Unacceptable Paving: Remove and replace unacceptable paving as directed by the Architect, immediately and without argument or delay. Correction of deficient areas in the wearing course shall be done by sawcutting and removal of defective area of work. Tack coat shall be applied to all edges and the pavement shall be replaced. Shimming or skin patching of the wearing course shall not be permitted. Correction of deficient areas within the binder course shall be corrected by sawcutting and milling high spots, and truing and leveling low spots or as directed by the Architect.

3.7 SURFACE PROTECTION

A. Protection: After final rolling and sealing, do not permit any type of vehicular or construction traffic on pavement until it has cooled and hardened as recommended by the producer/manufacturer, minimum of 48 hours.

B. Provide protection including, but not limited to, fencing, traffic cones, barrels, lights, reflective signs, flagpersons and barricades until mixture has cooled and attained its maximum degree of hardness.

3.8 PAINTED LINES, TRAFFIC AND RECREATIONAL MARKINGS

A. Cleaning: Sweep and clean surface to eliminate loose material and dust. Remove dirt, oils and other foreign matter. All surfaces to receive pavement markings shall be clean and in good condition to accept pavement markings.

B. Coordinate provisions for installation with work of other trades.

C. Locate to alignment and dimensions as shown on drawings and/or approved by Owner.

D. Painted markings shall meet regulations described in the "Manual of Uniform Traffic Control Devices", latest edition, as published by NYSDOT, Division of Traffic and Safety, Section 262.25 and figure PM-42; and they shall comply with the most recent version of the Americans with Disabilities Act Standards for Accessible Design.

E. Protect: Adjacent surfaces and other items to remain with tape, drop cloths, or other Architect approved means.

F. Application: Two coats according to manufacturer's recommendations resulting in a dense, opaque application without any ghosting of former pavement markings showing through. Overspraying along edges will not be accepted. Edges shall be sharp and crisp, to the shapes required by the drawings.

1. First coat shall be installed at the recommended DFT (dry film thickness) after paving is in place. The second coat shall be applied at the recommended DFT no later than thirty (30) days after the completion of work.

2. Apply paint materials using clean brushes, rollers or spraying equipment.

3. Apply paint materials as a rate not exceeding those recommended by the paint manufacturer for surfaces being painted, less 10% of losses

4. Comply with manufacturer's recommendations for drying time between coats. The minimum DFT must be met. Apply additional coats as needed to achieve minimum total specified DFT of the paint system.

5. The minimum required total Dry Film Thickness (DFT): The DFT shall be the minimum required thickness as measured in mils.
6. System coverage requirements minimum total thickness (unless otherwise noted):
   a. 1st Coat – 3.0 mils
   b. 2nd Coat – 6.0 mils

7. Exterior Paint Systems: Provide the following paint systems as indicated: (Colors to be approved by Owner.)
   a. Parking stall, division and limit lines shall be 4" in width, true and straight. Color: White – DFT 6.0 mils
   b. Pavement lettering "NO PARKING" shall be 2'-0" in height. Color: Yellow – DFT 6.0 mils
   c. Compact lettering "COMPACT" shall be 1'-0" in height. Color White – DFT 6.0 mils
   d. Stop legends shall be as detailed on drawings. Color: White – DFT 6.0 mils
   e. Wheelchair legends shall be as detailed on the drawings. Color: Blue background with white symbols. Parking stall striping shall be Blue at handicap stalls only – DFT 6.0mils
   f. Diagonal striping Handicapped. Color: Blue – DFT 6.0 mils
   g. Diagonal striping Loading Zone. Color: Yellow – DFT 6.0 mils
   h. Directional signage shall be as detailed on the drawings. Color: White – DFT 6.0 mils
   i. Center line striping shall be 4" in width as detailed on the drawings. Color: White – DFT 6.0 mils
   j. Fire line striping shall be 4" in width. Color: Yellow – DFT 6.0 mils
   k. Electric vehicle charger legends shall be as detailed on the drawings. Color: Green background with white symbols and border – DFT 6.0mils

G. Allow 48 hours minimum curing time for paint before allowing traffic on surfaces. Clean up thoroughly including all protective tape, spilled paint, and debris. All parking area marking and painting to be protected by appropriate traffic barriers, lighted if necessary,

so located as to prohibit parking and traffic until traffic lines are completed and properly dry.

3.9 ASPHALT SEALER

A. Thoroughly clean existing surface of dirt, oils and other debris by power washing and sweeping. Remove weeds and debris from cracks and fill with hot pour crack sealant NYSDOT as recommended by the manufacturer, flush with grade.

B. Asphalt Based Pavement Sealer shall be mixed in accordance with the following mix design (based on 100 gallons for ease of calculation). Contractor to adjust amount based on actual square yards to be applied:

Asphalt Based Concentrate	100 gals
Water	15-25 gals
Sealer Additive	2 gals
Sand*	400 lbs

*40-70 mesh AFS rating

C. Apply three (3) coats properly mixed Asphalt Based Pavement Sealer (Asphalt Based Concentrate, Water, Sand, Additive) at a rate 0.11 to 0.13 gallon per square yard (70-82 square feet per gallon) per coat. NOTE: The sealer is not designed to be a depression filler and shall not exceed a total depth of 3/16" for the two coats.

D. Both surface and ambient temperature shall be a minimum of 50°F. Temperature shall not drop below 50°F in a 24 hour period following application. New asphalt surfaces shall be allowed to cure a minimum of four weeks under ideal weather conditions (70°F) before applying Asphalt Based Concentrate Sealer.

3.10 HOT POUR CRACK SEALING AND FILLING

A. The crack must be free from moisture, dust, and loose aggregate. Routing or wire brushing are preferred methods followed by a compressed air heat lance immediately prior to sealing. The substrate and air temperature must be above 45°F.

B. Shall be melted in direct fired or oil jacketed melters. Material should reach recommended pouring temperature of 350-400°F. Fresh material may be added as sealant is used.

C. Apply heated crack filler using either a pump and wand system or a pour pot. For best results the sealant depth to width ratio should not exceed 2 to 1 (i.e. 2-inches deep to 1-inch wide). The cooled sealant height should not exceed 1/8" above surrounding pavement. Using a sealing shoe or squeegee, band the material 2 to 3 inches wide over the crack.

3.11 CLEAN UP

During the contract, and at intervals as directed by the Architect, and as asphalt paving is completed, clear the site of extraneous fabric, gravel, asphalt and debris. Leave the site in a clean, safe, well draining, neat condition.

END OF SECTION 321201

SECTION 321301 - SITE CONCRETE WORK

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. The extent of site concrete work is shown on the drawings and includes formwork, reinforcement, accessories, cast in place concrete, installation of embedded items, finishing, curing, mix designs, testing and acceptance requirements for concrete.

B. Site Concrete work includes, but is not limited to, the following:

1. Concrete walks, pads, and ramps
2. Concrete stairs
3. Concrete footings, bases, foundations, cradles, saddles, collars
4. Exterior anchoring cement non-shrink grout
5. Concrete scheduling April 1 to October 15
6. Clean up

C. Provide materials, labor, equipment and services required to accomplish related work in accordance with the drawings and specifications.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 312201 - Site Earthwork

B. Section 323000 Series - Site Improvements for Hand Railings, Safety Railings, Fencing

C. Section 334001 - Storm Drainage

1.3 REFERENCES

A. ACI 301-96 - Specifications of Structural Concrete for Buildings

B. ASTM A615 - Deformed and Plain Billet-Steel for Concrete Reinforcement

C. ASTM C31 - Standard Practice for Making and Curing Test Specimens in the Field

D. ASTM C33 - Concrete Aggregate

E. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

F. ASTM C94 - Ready-Mixed Concrete

G. ASTM C109 - Test Method for Compressive Strength of Hydraulic Cement Mortars

H. ASTM C143 - Standard Test Method for Slump of Hydraulic Cement Concrete

I. ASTM C1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-Shrink)

J. ASTM C150 - Portland Cement

K. ASTM C172 - Standard Practice for Sampling Freshly Mixed Concrete

L. ASTM C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by Volumetric Method

M. ASTM C260 - Air Entraining Admixtures for Concrete

N. ASTM C309 - Liquid Membrane-Forming Compounds for Curing Concrete

O. ACI 315 - Details and Detailing Concrete Reinforcement

1.4 SUBMITTALS: (See Section 311201, 1.5)

A. Shop Drawings required for:

1. Concrete stairs showing reinforcing

B. Manufacturers Product Data (MPD) and Samples where indicated are required for the following:

1. Expansion Joint and Sealant (Vertical and Horizontal): MPD and Color Samples
2. Water Based Curing and Sealing Compound
3. Slip Dowel System
4. Cold Weather Admixture
5. Hot Weather Admixture
6. Air Entrainment
7. Form Release
8. Exterior Anchoring Cement Non-Shrink Grout
9. High Strength Anchoring Epoxy System
10. Concrete Bonding Agent

C. Submit proposed 4,500 psi and 5,000 psi concrete mix design(s) and test data in accordance with ACI 301 to the Architect for review prior to commencement of the work.

1. Indicate the locations and elements for which the mix will be used.
2. Include in the concrete mix designs all required or proposed admixtures necessary to facilitate the installation of the concrete by the means and methods selected by Contractor for this project.

D. Mill test certificates and/or test reports for cement indicating compliance with these specifications.

1.5 QUALITY ASSURANCE

A. Concrete Testing Services: The Owner shall employ an acceptable independent testing laboratory to perform materials evaluation, testing of concrete mixes, and quality control

testing. Coordinate day to day scheduling with the testing agency. Field technician shall be ACI Certified Grade 1 Field Technician.

B. Construct and erect concrete formwork in accordance with ACI 301 and 347.

C. Perform concrete reinforcing work in accordance with ACI 301.

D. Perform cast-in-place concrete work in accordance with ACI 301.

E. Conform to New York State Building Code.

F. Field quality control tests are specified in Part 3 - Execution.

1.6 JOB CONDITIONS

A. Job conditions in Section 312201 apply. Provide ample and skilled manpower for concrete installation which is a recognized time sensitive procedure.

B. All concrete work shall conform to American Concrete Institute (ACI) 304R-00 "Guide for Measuring, Mixing, Transporting and Placing Concrete".

C. Do not install concrete work when the temperature of the outside air is below 50 degrees F. and falling unless suitable means acceptable to the Architect are provided to protect work from cold and frost and ensure that mortar and concrete will cure without freezing as indicated in "Cold Weather Concreting" below.

D. Cold Weather Concreting: Provide non-chloride accelerating water reducing admixture in site concrete work placed at ambient air temperatures below 50 degrees F. (10 degrees C.). Comply with International Masonry Industry All-Weather Council cold weather construction and protecting recommendations and American Concrete Institute 306R-10 "Guide to Cold Weather Concreting."

E. Hot Weather: Provide water reducing retarding admixture in site concrete work placed at ambient air temperatures above 80° F. Comply with American Concrete Institute 305R-10 "Guide to Hot Weather Concreting."

F. Construction Review: Notify the Architect/Geotechnical Engineer when stairs, retaining walls, walks, ramps, curbs and pads are formed and ready to receive concrete. Radius form layout shall be inspected and approved by the Architect.

G. Schedule: Unless otherwise directed in writing by the Architect, construct site concrete work from April 1 to October 15. This permits a minimum 30 day dry curing period prior to possible application of deicing chemicals by the Owner.

H. Site concrete work performed between October 16 and March 30 will require an additional written one (1) year guarantee with the understanding that above average concrete deterioration and replacement by the Contractor is likely. Or;

Provide temporary light duty asphalt access paths and replace with permanent concrete during the following April 1 to October 15 timeframe. Both options are at no additional cost to the Owner.

1.7 ADA REQUIREMENTS

A. GENERAL: Concrete work shall comply with the Americans With Disabilities Act as described in the 2010 ADA Standards issued by the Department of Justice (DOJ) and the Department of Transportation (DOT) or latest edition, shall be used.

B. Curb ramp and concrete walk surfaces shall meet the following tolerances:

1. Transitions from ramps to walks, gutters, or streets shall be flush and free of abrupt changes.
2. Thresholds at doorways shall not exceed 3/4" in height for exterior sliding doors or 1/2" for other types of doors. Raised thresholds and floor level changes at accessible doorways shall be beveled with a slope no greater than 1:2.

PART 2 - PRODUCTS

2.1 FORM MATERIALS AND ACCESSORIES

A. Forms: Either steel or wood, exterior type softwood, PS1, of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Use forms that are straight and free of distortion and defects, extending the full depth of concrete. Concrete walks which require radius form work shall be set with flexible forms, conforming to the shapes and dimensions as indicated.

B. Lumber: PS 20.

C. Form Ties: Snap-off, metal type of fixed length, cone type.

1. Ties shall be left in place and equipped with swaged washers or other approved devices to prevent seepage of moisture along the tie.
2. Depth of Breakback: Minimum one (1") inch.
3. Unless otherwise noted, provide form ties, which will not leave holes larger than one (1") inch diameter in concrete surface.

D. Dovetail Anchor Slot: Galvanized steel, form filled, release tape sealed slots; bend tab anchors.

E. Form Release Agent: Shall be non-staining and non-residual. Increte Wall Form Release manufactured by Increte or Architect approved equal.

2.2 REINFORCEMENT MATERIALS

A. Reinforcing Steel: ASTM A615, 60 ksi yield grade; deformed billet steel bars, plain finish, free of rust and/or oxidation. Reinforcing bars shall be bundled and tagged with grades and suitable identification markings, shall be waterproof, and shall not be removed until steel is placed.

B. Steel Welded Wire Reinforcement ASTM A185, plain type:

1. Flat Sheets

2. Mesh size: 6 x 6 (standard W1.4 x W1.4, heavy duty W2.1 x W2.1)
3. Free of rust and/or oxidation

C. Reinforcement Accessories:

1. Tie Wire: FS QQ- W-461 G, annealed steel, back, 16-gage minimum.
2. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for adequate support of reinforcement during concrete placement. They shall provide sufficient supports at close enough spacing so that the steel will carry the weight of the workmen and the fresh concrete without deformation from its specified location.

D. Fabricate concrete reinforcing in accordance with ACI 315.

E. Slip Dowels: Shall be a slip dowel system comprised of a round dowel sleeve and corresponding base. Standard of quality: shall be Speed Dowel as distributed by A.H. Harris, (860) 216-9500 or Architect approved equal.

2.3 CONCRETE MATERIALS

A. Cement: ASTM C150, Normal-Type 1 or Type II, Portland type.

B. Aggregates (ASTM C33):

1. Fine aggregates: clean, sharp, natural sand.
2. Coarse Aggregates: 3/4" maximum size stone meeting the requirements of New York State Department of Transportation Specification 703.02.

C. Water: Clean and not detrimental to concrete.

2.4 ADMIXTURES

A. Calcium Chloride in concrete is prohibited.

B. Air Entrainment Admixture: ASTM C260, Darex AEA ED or Architect approved equal.

C. Water Reducing Admixture: ASTM C494, Type A; not containing more chloride ions than are present in municipal drinking water.

D. High Range Water Reducing Admixture: ASTM C494, Type F or G; not containing more chloride ions than are present in municipal drinking water.

E. Cold Weather Accelerating Admixture: (Ambient temperature below 50°F.) Non-chloride water reducing accelerating admixture, ASTM C494, Type C, PolarSet as manufactured by WR Grace & Co. or Architect approved equal. Mix at rates recommended by the manufacturer. No reduction in compression rating of the concrete is permitted.

F. Hot Weather Water Reducing and Retarding Admixture: (Ambient temperature above 80° F.) Shall be Daratard series admixture, ASTM C494, Type D, as manufactured by WR Grace & Co. or Architect approved equal. Mix at a rate recommended by the manufacturer. No reduction in compression rating of the concrete is permitted.

2.5 RELATED MATERIALS

A. Expansion Joints:

1. For Radius Applications: Expansion joint filler shall be polyethylene closed cell backing with peel off strip, X-Foam as manufactured by W.R. Meadows or Architect approved equal.
2. For Straight Applications: Expansion joint filler shall be fiber expansion joint with peel off snap-cap, as manufactured by W.R. Meadows or Architect approved equal.

B. Caulking for flat slabs shall be one part elastomeric self leveling polyurethane gray sealant Pourthane SL or Architect approved equal. Caulking for vertical surfaces shall be one component elastomeric gun grade polyurethane sealant Pourthane NS, color as selected by the Owner to match wall stain or Architect approved equal.

2.6 COMPOUNDS, HARDENERS, AND SEALERS

A. Water Based, Acrylic, Curing and Sealing Compound: ASTM C309, Type 1, Class A and B, clear or translucent. Standard of quality shall be VOCOMP-20 as manufactured by W.R. Meadows or Architect approved equal.

B. Water Based Penetrating Sealer: clear, penetrating, breathable, VOC-compliant, solvent free surface treatment for use on concrete to protect against water and chloride intrusion. Standard of quality shall be Protectosil 300 S as manufactured by Evonik Corporation or Architect approved equal.

2.7 CONCRETE MIX

A. Mix and deliver ready-mix concrete in accordance with ASTM C94.

B. Concrete at walkways, footings, curbs, ramps, and slabs:

1. Compressive Strength (Minimum at 28 days): 4,500 psi
2. Slump (Maximum): 4 inches +/- 1”
3. Air Entrainment: 6 – 8.5% +/- 1.5%
4. Flexural Strength (ASTM C78): 650 psi at 28 days.

C. Concrete at stairs:

1. Compressive Strength (Minimum at 28 days): 5,000 psi
2. Slump (Maximum): 4 inches +/- 1”
3. Air Entrainment: 6 – 8.5% +/- 1.5%
4. Flexural Strength (ASTM C78): 650 psi at 28 days.

D. Use water-reducing admixture in all concrete.

E. Water/Cement Ratio: Maximum 0.45 for 4,500 psi concrete.

F. Substitution of fly ash for cement is prohibited.

G. Maximum Size of Coarse Aggregate:

1. General Work: Per ACI 301, 3/4" maximum.

H. Select admixture proportions for normal weight concrete in accordance with ACI 301.

I. Add air-entraining agent to concrete mix for all concrete work exposed to exterior.

2.8 MIXING WATER CONTROL

A. The quantity of mixing water used in the concrete mix shall be determined by the Contractor, except that the Architect/Geotechnical Engineer may direct that such quantity of water be reduced if the slump of the concrete exceeds the specified slump. The Contractor's determination of the quantity of mixing water shall conform to the various limits on water/cement ration and slump specified. Concrete consistency shall be uniform from batch to batch.

B. During the course of the work, the batch plant will make quantitative measured moisture determinations of the aggregates utilized in each batch. Aggregate weights and batch water requirements shall be adjusted accordingly for measured aggregate moisture content.

C. When concrete is transported in units approved for mixing, the addition of not more than 10% of the total design water will be permitted at the job site to obtain initial slump.

1. Any addition of water shall be followed by mixing of at least 30 revolutions in the mixing speed range.
2. No more than two additions of water at the point of deposition before discharge shall be allowed.
3. No retempering of the concrete will be permitted. Retempering is defined as the addition of water after the mix has attained its desired initial slump.

2.9 EXTERIOR ANCHORING CEMENT (NON-SHRINK GROUT)

A. For Steel Posts, Fencing and Other Non-Aluminum Elements: Shall be an exterior grade anchoring cement (non-shrink grout) with a min. compressive strength (ASTM C-109) of 7,200 psi at 28 days. Standard of quality shall be Super Por-Rok as manufactured by CGM, Inc., www.cgmbuildingproducts.com, or Architect approved equal.

B. For Aluminum Posts and Elements: Shall be an exterior grade anchoring cement (non-shrink grout) with a min. compressive strength (ASTM C-109) of 7,200 psi at 28 days. Standard of quality shall be Por-Rok as manufactured by CGM, Inc., www.cgmbuildingproducts.com, or Architect approved equal.

2.10 HIGH STRENGTH ANCHORING EPOXY SYSTEM

A. A two-component vinylester adhesive anchoring system. The system includes injection adhesive in plastic cartridges, mixing nozzles, dispensing tools and hole cleaning equipment.

B. Designed for bonding threaded rod and reinforcing bar elements into drilled holes in concrete and masonry base materials.

C. Standard of quality shall be AC100+ GOLD Vinylester Injection Adhesive Anchoring System as distributed by A.H. Harris, (315) 414-0340, or Architect approved equal.

2.11 CONCRETE BONDING AGENT

A. Shall be a concrete bonding adhesive specifically formulated for permanently bonding new concrete to old concrete in exterior applications.

B. Concrete bonding adhesive applied to appropriate substrates will achieve tensile bond strengths typical of 150 psi in 28 days.

C. Standard of quality shall be Quickrete Concrete Bonding Adhesive or Architect approved equal.

PART 3 - EXECUTION

3.1 CONCRETE WALKS, PADS, AND RAMPS

A. Surface Preparation: Remove loose material from the compacted subgrade surface immediately before placing concrete. Remove any standing water, mud, debris, frost, snow, ice from surfaces upon or against which concrete is to be placed.

B. Proof-roll prepared subgrade surface to check for unstable areas and the need for additional compaction. Do not begin concrete pour until such conditions have been corrected, subgrade is compacted to 95% and ready to receive concrete.

C. Form Construction: Construct to required size and shape. Brace and secure to maintain alignment, elevation and position. Check completed formwork for grade and alignment, prior to installing concrete. Clean forms as needed to removed foreign matter.

D. Install welded wire mesh on concrete brick or mesh chairs to proper level in maximum lengths possible. Offset end laps in both directions. Splice laps with tie wire. Lifting mesh after concrete pouring is not acceptable.

E. Prepare concrete mixture including the following:

1. Add hot weather or cold weather admixture to accommodate field weather conditions.

F. Concrete Testing: Will be performed as described in Part 3, "Field Quality Control" of this specification section.

G. Conveying:

1. Convey concrete by means that will prevent segregation and loss of mortar form the mix.
2. Provide adequate manpower and equipment in the form of buckets, buggies, chutes, conveyors or other approved means to assure continuous operation.

3. Convey concrete so that no equipment with aluminum parts comes in contact with fresh concrete.

H. Concrete Placement: Do not place concrete until subgrade and forms have been checked for line and grade. Moisten granular base course as required to provide a uniform dampened condition at the time concrete is placed. Do not place concrete around manholes or other structures until they have been brought to the required finish grade, alignment, and expansion joints have been installed.

I. Spread concrete as soon as it is deposited on the granular base course, using methods which prevent segregation of the mix, and with as little rehandling as possible. Consolidate concrete along the face of forms. Consolidate with care to prevent dislocation of mesh, reinforcing and joint materials.

J. Install Concrete Walk Joints:

1. Construct expansion and contraction joints as detailed and as shown on plans. Concrete joints that do not follow the pattern(s) shown on the plans and/or changes that have been approved by the Architect will be removed and replaced at no additional cost to the Owner.
2. When the walkway is abutting existing walks, place transverse joints to align with previously placed joints, unless otherwise shown.
3. Contraction Joints: Approximately 5' on center. Break walk into individual slabs of not more than twenty-five (25 sf) square feet with jointing tool, round edges. Saw cut scoring pattern (contraction joints) to depth shown on details for each type of concrete work with new, sharp concrete sawblade one day (24 hours) after the pour. Joint cuts to be clean, sharp, uniformly made cuts to achieve scoring pattern as shown and detailed. Note: When tooled joints or saw cutting is not performed as described, an extended three (3 yr.) year written guarantee or credit for defective work will be required as determined by the Architect at no additional cost to the Owner.
4. Expansion Joints: Provide where abutting building(s), columns, structures, concrete paving and curbs, catch basins, manholes, inlets, walks, walls, other fixed objects and as directed by the Architect.
5. Locate expansion joints at thirty feet on center (30' o.c.) for each walkway lane, unless otherwise shown. Provide slip dowels as detailed and specified.
6. Locate expansion joints with slip dowels at all flush building access points, whether specifically shown on drawings or not.
7. Extend joint fillers full width and depth of the joint, flush with finished pavement grade, and not less than 1/4" or more than 1/2" below the finished pavement surface. Joint surfaces shall be clean and dry prior to installation of sealant as per manufacturer's recommendations. Remove excess sealant on surfaces adjacent to joint.

K. Concrete Finishing:

1. Perform concrete finishing using machine or hand methods as required.
2. After striking off and consolidating concrete, smooth the surface by screeding and floating. Use hand methods only where mechanical floating is not possible. Adjust the floating to compact the surface and produce a uniform texture.

3. After floating, test surface for trueness with a ten (10') foot straightedge. Distribute concrete as required to remove surface irregularities, and refloat repaired areas to provide a continuous, smooth finish.
4. Work edges of slabs and joints with a 1/8" radius edging tool, two (2") wide, unless otherwise shown.
5. After completion of floating and when excess moisture or surface sheen has disappeared, complete surface finishing, as follows.
6. Broom finish, by drawing a medium hair broom across the concrete surface as detailed. Repeat operation when required to provide a medium texture acceptable to the Architect.
7. For handicap curb ramps, tool grooves along sloping surfaces in line with drainage flow as detailed.
8. Curing: Refer to schedule noted in 1.6, above.

    a. Immediately after placement, protect concrete form premature drying.
    b. Remove all dirt, dust, oil, grease, asphalt and foreign matter. Cleanse with caustics and detergents as required. Rinse thoroughly and allow to dry.
    c. Stir curing compound thoroughly before using.
    d. Apply a continuous, uniform film by solvent-resistant low pressure spray only, short-nap roller or lamb's wool applicator. For best results, use a canister curing compound sprayer. Use spray tip number 8004 or equivalent for water-based or waterborne products.
    e. For curing, apply first coat evenly and uniformly as soon as possible after final finishing. Apply second coat when all construction is completed and structure is ready for occupancy.
    f. When soil contamination occurs, notify the Architect immediately in writing. Remove contaminated soils and legally dispose of, provide soil test(s), replace soil, plantings and lawns at no additional cost to the Owner.

3.2 CONCRETE STAIRS

A. General: Concrete stairs shall meet the requirements specified for concrete in this Section, Item 3.1, except as noted below.

B. Verify that lines, levels, locations and form dimensions comply with drawings and submittals.

C. Design, erect, support, brace, and maintain formwork to support applied vertical and lateral loads. Construct formwork to provide correct size, alignment, elevation, pitch on tread, and position of concrete work.

D. Design and erect formwork to permit removal without damage to cast-in-place concrete surfaces and adjacent materials during stripping.

E. Install, align, and level forms. Support and brace forms in place.

F. Coat form surfaces with form release agent. Clean forms after each use and coat with form release agent as necessary to assure separation from concrete without damage. Apply before placing reinforcing steel, anchoring devices, and embedded items.

G. Provide reinforcing bars adequately supported and secured to prevent displacement.

H. Placement of concrete shall be in layers not to exceed 18 inches without consolidation with the aid of mechanical vibrating equipment. To achieve even and dense surfaces, free of aggregate pockets or honeycomb, vibration shall be supplemented by spading by hand in the corners and angles of forms and along surface while concrete is plastic under the vibratory action. Placement of concrete shall conform to recommendations of ACI 309 "Recommended Practice for Consolidation of Concrete".

I. Install, set, and build-in items furnished by other trades. Provide adequate notification for installation of necessary items. Coordinate with reinforcing, safety railings and hand railings.

J. Remove ties and patch tie holes, including those below grade. Remove fins and patch minor voids. Chip out major stone pockets and repair. Rub surface smooth with carborundum brick dipped in neat cement grout to fill pin holes. Trowelled on cement plaster is prohibited. After drying, rub off all excess cement dust with burlap.

K. Medium broom finish stair treads with strokes perpendicular to flow of pedestrian traffic, similar to walks. Other exposed concrete surfaces shall be rub finished similar to concrete curb.

L. Cure and seal as specified in this section, item 3.1 above.

M. Strip Forms and Bracing: Three (3) days minimum before stripping. It is the Contractor's responsibility to determine the time at which forms may be removed without damaging the stairs and only after concrete has gained sufficient strength to carry its own weight and imposed loads.

3.3 FOOTINGS, BASES, FOUNDATIONS, SADDLES, CRADLES, COLLARS

A. Footings, Bases, Foundations: Locate and provide where shown on drawings and as detailed.

B. Saddles: Locate and provide where shown on drawings or where vertical distance between crossing pipes is eighteen (18") inches or less. Construct saddles springline (centerline) to springline and full width of trenches.

C. Cradles: Locate and provide where shown on drawings. Construct cradles the full width of the trench, six (6") inches below the pipe and on both sides of the pipe up to the springline.

D. Collars: Locate and provide where shown on drawings or where pipe slopes exceed ten (10%) percent. Construct collars one (1') foot thick, full width of trench plus one (1') foot extension each side, above and below pipe.

3.4 INTERRUPTION OF CONCRETING

A. Should placing concrete be suspended or unavoidably interrupted, provide key ways and bulkheads to prevent feather-edging when work is resumed. Roughen horizontal surface for bond.

3.5 REPAIR AND PROTECTION FOR CONCRETE WORK

A. Cut out and replace defective concrete work which has blisters, cracking, crazing, curling, discoloration, dusting, efflorescence, low spots, pop outs, scaling or mortar flaking, spalling, settling, or heaving as defined by Portland Cement Association 2001, "Concrete Slab Surface Defects" and as directed by the Architect.

B. Modify or replace concrete not conforming to the required lines, details, elevations and specifications as directed by the Architect.

C. Protect the work from damage until acceptance of the work. Exclude traffic from concrete work for at least fourteen (14) days after placement. When construction traffic is permitted, maintain concrete as clean as possible by removing surface stains and spillage of materials as they occur.

3.6 ANCHORING RAILINGS AND POSTS INTO CONCRETE

A. Aluminum posts **must** be coated or treated with a good sealer or paint prior to anchoring.

B. Drill the hole as detailed. Blow out all dust and loose particles.

C. Fill the hole with water. Scrub the sides and bottom of the hole and with a stiff wire brush such as a bottlebrush. This is important.

D. Remove excess water with rag or other absorbent materials. Leave the hole clean and uniformly damp.

E. Mix the anchoring cement in a clean container to flowable consistency based on the following formula. For best results, measure accurately. The correct amount of water is as follows:

2.3 oz per lb
11.5 oz for 5 lbs
115 oz for 50 lbs
7 quarts for 100 lbs

Measure the amount of anchoring cement and water to be mixed. Add the measured amount of water to the appropriate amount of cement and mix until the desired consistency is achieved. (NEVER USE MORE WATER THAN PRESCRIBED). This will reduce the ultimate strength, increase the possibility of volume instability and may cause the product to become soft and less durable.)

F. Fill the hole with the plastic cement first, and then tamp the bolt, post or rod with a twisting motion into place. If the material becomes too fluid during the tamping process and sags out of place, let it stand for a few minutes and it will stiffen. Smooth out the surface around the bolt with spatula or trowel.

G. Let the cement harden for at least 60 minutes. For heavy equipment, allow 4 hours prior to use or loading.

3.7 ANCHORING BOLTS, DOWELS, AND REBAR INTO CONCRETE

A. Anchor Hole Preparation: Prepare all anchor holes prior to placement of anchoring epoxy. Hole diameter is typically 1/8" (3 mm) greater than the anchor diameter. Hole depth is typically nine times anchor diameter. Required minimum anchor hole depth is 6". Consult project specifications and details. Drill hole to proper diameter and depth and blow all dust from the bottom of the hole, brush and blow (4x) repeatedly to remove all dust and debris. The anchor hole must be clean and free of standing water prior to placement of material.

B. Application: Use only professional caulking gun. Remove plastic cap and plugs from cartridge. Save for closing cartridge. Attach mixing nozzle to cartridge. Discard small amount of gunned product until uniform color is achieved. Mixing nozzle will harden in approximately 20 min. if not in use.

C. Hardened nozzle must be discarded. Dispense the epoxy at the bottom of the hole while withdrawing nozzle. Dispense epoxy (typically filling 5/8 of hole) so that once threaded rod or rebar is inserted, the hole is completely full. Insert threaded rod or rebar to the bottom of the hole while turning clockwise. Promptly remove any excess material. Leave anchor undisturbed for 6 hours (at 77°F /25°C), or longer for colder temperatures. Load can be applied 8 hours at 77°F (25°C).

3.8 CONCRETE BONDING AGENT

A. Required at elements where new concrete is applied and joined to existing concrete.

B. Surface Preparation:

1. Apply only to clean, sound, dry surfaces.
2. Remove dust, dirt, oil, grease, wax, unsound concrete and plaster, paint, and other foreign materials.

C. Applications:

1. Apply to a dry surface with brush, roller or spray to the thickness of a coat of paint.
2. Place new concrete, topping mixes, Portland cement, or patches as soon as the adhesive is dry.
3. Make sure basecoat is dry before applying adhesive.
4. Tools, brushes and other application accessories should be immediately cleaned with soapy water. Use hot water to clean up any drippings.

3.9 FIELD QUALITY CONTROL

A. Field inspection and testing shall be performed by ACI certified technicians; Grade 1. Certificates shall be submitted to the Architect for persons performing inspection and testing prior to the start of work.

B. Field Inspection and testing shall be paid for as directed under 1.5 "Quality Assurance". Where retesting, additional inspection, lab tests or other professional services are required due to rejected work, any cost associated therewith will be solely at the Contractor's expense.

C. The Contractor shall plan his operations to allow adequate time for all required testing and inspection.

D. The Contractor shall provide facilities and equipment necessary to obtain and handle representative sample of materials to be tested.

E. The testing laboratory shall be responsible to the Owner for the field control of all concrete and may reject batches because of high slump, uncontrolled air entrainment, delays or other conditions of non-compliance with these specifications.

F. Sampling and Field testing will be performed during concrete placement per ASTM C31, C39, C143, C172 and C173.

G. Five (5) Concrete Test Cylinders: Taken for every 30 or less cubic yards of concrete placed are required or a fraction thereof;

1. Two (2) Cylinders will be tested at 7 days, two (2) cylinders will be tested at 28 days and one (1) cylinder will be held for possible testing at a later time.

H. One (1) Additional Test Cylinder: Taken during cold weather concreting, to be cured on the job site under the same conditions as placed concrete it represents, is required.

I. Air Content Test: Taken for each set of test cylinders taken, is required.

J. One (1) Slump Test: Taken for each set of test cylinders taken is required.

K. Test results will be reported by telephone to the General Contractor and Architect on same day tests are made. Written report with copies will follow to the Owner, Architect, and Landscape Architect. Email copies of laboratory test, evaluation reports for concrete materials and mix designs will be submitted.

3.10 CLEAN UP

During the contract and at intervals as directed by the Architect and as concrete work is completed, clear the site of gravel, concrete, appurtenances and debris. Leave the site in a clean, safe, well draining, neat condition.

END OF SECTION 321301

SECTION 321301 - SITE CONCRETE WORK

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. The extent of site concrete work is shown on the drawings and includes formwork, reinforcement, accessories, cast in place concrete, installation of embedded items, finishing, curing, mix designs, testing and acceptance requirements for concrete.

B. Site Concrete work includes, but is not limited to, the following:

1. Concrete walks, pads, and ramps
2. Concrete curbs, stairs and retaining wall
3. Concrete footings, bases, and foundations
4. Exterior anchoring cement non-shrink grout
5. Concrete scheduling April 1 to October 15
6. Clean up

C. Provide materials, labor, equipment and services required to accomplish related work in accordance with the drawings and specifications.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 312201 - Site Earthwork

B. Section 323000 Series – Powder Coated Steel Safety and Handrails, Steel Swing Gate, Metal Bollards, Traffic Signs

C. Section 334001 - Storm Drainage

1.3 REFERENCES

A. American Concrete Institute (ACI), latest editions:
1. 301-96 – Specification for Structural Concrete Buildings
2. 304R - Guide for Measuring, Mixing, Transporting and Placing Concrete
3. 306R-16 – Guide to Cold Weather Concreting
4. 315 - Details and Detailing Concrete Reinforcement
5. 347 – Guide to Formwork for Concrete

B. Portland Cement Association (PCA). “Design and Control of Concrete Mixtures”, latest edition.

C. American Society for Testing and Materials (ASTM):
1. ASTM A615 - Deformed and Plain Billet-Steel for Concrete Reinforcement
2. ASTM C31 - Standard Practice for Making and Curing Test Specimens in the Field
3. ASTM C33 - Concrete Aggregate
4. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
5. ASTM C94 - Ready-Mixed Concrete

6. ASTM C109 - Test Method for Compressive Strength of Hydraulic Cement Mortars
7. ASTM C143 - Standard Test Method for Slump of Hydraulic Cement Concrete
8. ASTM C1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-Shrink)
9. ASTM C150 - Portland Cement
10. ASTM C172 - Standard Practice for Sampling Freshly Mixed Concrete
11. ASTM C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by Volumetric Method
12. ASTM C260 - Air Entraining Admixtures for Concrete
13. ASTM C309 - Liquid Membrane-Forming Compounds for Curing Concrete

1.4 SUBMITTALS: (See Section 311201, 1.5)

A. Steel Reinforcement Shop Drawings that detail fabrication, bending, and placement. Comply with CRSI – Manual of Standard Practice showing bar schedules, stirrup spacing, diagrams of bent bars, arrangement of concrete reinforcement, mechanical connections, tie spacing, hoop spacing required for:

1. Concrete stairs and ramps showing reinforcing
2. Retaining wall(s) and foundations
3. Curbs

B. Manufacturers Product Data (MPD) and Samples where indicated are required for the following:

1. Expansion Joint and Sealant (Vertical and Horizontal): MPD and Color Samples
2. Water Based Curing and Sealing Compound
3. Water Based Penetrating Sealing Compound
4. Slip Dowel System
5. Cold Weather Admixture
6. Hot Weather Admixture
7. Air Entrainment
8. Form Release
9. Exterior Anchoring Cement Non-Shrink Grout
10. High Strength Anchoring Epoxy System
11. Concrete Bonding Agent

C. Submit proposed 4,500 psi and 5,000 psi concrete mix design(s) and test data in accordance with ACI 301 to the Architect for review prior to commencement of the work.

1. Indicate the locations and elements for which the mix will be used.
2. Include in the concrete mix designs all required or proposed admixtures necessary to facilitate the installation of the concrete by the means and methods selected by Contractor for this project.

D. Mill test certificates and/or test reports for cement indicating compliance with these specifications.

E. Formal Letter from Concrete Contractor and/or Concrete Supplier with recommendations of materials to be used to maintain and remove ice / snow from newly installed concrete surfaces. The letter should also reference the potential damage of concrete surfaces from the use of de-icing chemicals and rock salt, by the Owner, during the first (1) year of concrete curing, from the date of placement.

1.5 QUALITY ASSURANCE

A. Concrete Testing Services: The Owner shall employ an acceptable independent testing laboratory to perform materials evaluation, testing of concrete mixes, and quality control testing. Coordinate day to day scheduling with the testing agency. Field technician shall be ACI Certified Grade 1 Field Technician.

B. Construct and erect concrete formwork in accordance with ACI 301 and 347.

C. Perform concrete reinforcing work in accordance with ACI 301.

D. Perform cast-in-place concrete work in accordance with ACI 301.

E. Conform to New York State Building Code.

F. Field quality control tests are specified in Part 3 - Execution.

1.6 JOB CONDITIONS

A. Job conditions in Section 312201 apply. Provide ample and skilled manpower for concrete installation which is a recognized time sensitive procedure.

B. All concrete work shall conform to American Concrete Institute (ACI) 304R-00 "Guide for Measuring, Mixing, Transporting and Placing Concrete".

C. Do not install concrete work when the temperature of the outside air is below 50 degrees F. and falling unless suitable means acceptable to the Architect are provided to protect work from cold and frost and ensure that mortar and concrete will cure without freezing as indicated in "Cold Weather Concreting" below.

D. Cold Weather Concreting: Provide non-chloride accelerating water reducing admixture in site concrete work placed at ambient air temperatures below 50 degrees F. (10 degrees C.). Comply with International Masonry Industry All-Weather Council cold weather construction and protecting recommendations and American Concrete Institute 306R-10 "Guide to Cold Weather Concreting."

E. Hot Weather: Provide water reducing retarding admixture in site concrete work placed at ambient air temperatures above 80° F. Comply with American Concrete Institute 305R-10 "Guide to Hot Weather Concreting."

F. Construction Review: Notify the Architect/Geotechnical Engineer when stairs, retaining walls, walks, ramps, curbs and pads are formed and ready to receive concrete. Radius form layout shall be inspected and approved by the Architect.

G. Schedule: Unless otherwise directed in writing by the Architect, construct site concrete work from April 1 to October 15. This permits a minimum 30 day dry curing period prior to possible application of deicing chemicals by the Owner.

H. Site concrete work performed between October 16 and March 30 will require an additional written one (1) year guarantee with the understanding that above average concrete deterioration and replacement by the Contractor is likely. Or;

Provide temporary light duty asphalt access paths and replace with permanent concrete during the following April 1 to October 15 timeframe. Both options are at no additional cost to the Owner.

1.7 ADA REQUIREMENTS

A. GENERAL: Concrete work shall comply with the Americans With Disabilities Act as described in the 2010 ADA Standards issued by the Department of Justice (DOJ) and the Department of Transportation (DOT) or latest edition, shall be used.

B. Concrete walk surfaces shall meet the following tolerances:

1. Transitions from ramps to walks, gutters, or streets shall be flush and free of abrupt changes.
2. Thresholds at doorways shall not exceed 3/4" in height for exterior sliding doors or 1/2" for other types of doors. Raised thresholds and floor level changes at accessible doorways shall be beveled with a slope no greater than 1:2.

1.8 CONCRETE FIELD MOCKUP(S)

A. CONCRETE FLAT WORK (using Type 1L Concrete):
1. Prior to installation of concrete flatwork using Type 1L concrete, erect a 5’ x 5’ minimum sample panels in place to further verify finishing time, slump, and setting time.
2. Construct at least two (2) weeks before start of other concrete work to allow concrete to set up before observation.
3. Mockup shall demonstrate each forming and finishing condition required on Project using materials, workmanship, joint treatment, curing method, and finishinig techniques to be used throughout the project.
4. Retain samples of cement and aggregates used in mockup for comparison with materials used in remaining work.
5. When Architect determines that mockup does not meet requirements, demolish and remove it from the site and cast another until mockup is accepted.
6. Keep accepted mockup undisturbed during construction as a standard for judging competed work.
7. Demolish accepted mockup and dispose offsite only when directed by the Architect.

PART 2 - PRODUCTS

2.1 FORM MATERIALS AND ACCESSORIES

A. Forms: Either steel or wood, exterior type softwood, PS1, of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Use forms that are straight and free of distortion and defects, extending the full depth of concrete. Concrete walks which require radius form work shall be set with flexible forms, conforming to the shapes and dimensions as indicated.

B. Lumber: PS 20.

C. Form Ties: Snap-off, metal type of fixed length, cone type.

1. Ties shall be left in place and equipped with swaged washers or other approved devices to prevent seepage of moisture along the tie.
2. Depth of Breakback: Minimum one (1") inch.
3. Unless otherwise noted, provide form ties, which will not leave holes larger than one (1") inch diameter in concrete surface.

D. Dovetail Anchor Slot: Galvanized steel, form filled, release tape sealed slots; bend tab anchors.

E. Form Release Agent: Shall be non-staining and non-residual. Increte Wall Form Release manufactured by Increte or Architect approved equal.

2.2 REINFORCEMENT MATERIALS

A. Reinforcing Steel: ASTM A615, 60 ksi yield grade; deformed billet steel bars, plain finish, free of rust and/or oxidation. Reinforcing bars shall be bundled and tagged with grades and suitable identification markings, shall be waterproof, and shall not be removed until steel is placed.

B. Steel Welded Wire Reinforcement ASTM A185, plain type:

1. Flat Sheets
2. Mesh size: 6 x 6 (standard W1.4 x W1.4, heavy duty W2.1 x W2.1)
3. Free of rust and/or oxidation

C. Reinforcement Accessories:

1. Tie Wire: FS QQ- W-461 G, annealed steel, back, 16-gage minimum.
2. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for adequate support of reinforcement during concrete placement. They shall provide sufficient supports at close enough spacing so that the steel will carry the weight of the workmen and the fresh concrete without deformation from its specified location.

D. Fabricate concrete reinforcing in accordance with ACI 315.

E. Slip Dowels: Shall be a slip dowel system comprised of a round dowel sleeve and corresponding base. Standard of quality: shall be Speed Dowel as distributed by A.H. Harris, (860) 216-9500 or Architect approved equal.

2.3 CONCRETE MATERIALS

A. Cementitious Materials: Use the following cementitious materials or the same type, brand, and source throughout the project:
   1. Portland Cement: ASTM C 150, Type I/II.
   2. Fly Ash: ASTM C 618, Class F or C, with loss on ignition less than 6%.
   3. Slag Cement: ASTM C 989, Grade 100 or 120.
   4. Blended Hydraulic Cement*: ASTM C 595 Type 1L.

      *Use of Blended Hydraulic Cement (Type 1L) requires additional project requirements prior to approval / use within this specification.

B. Aggregates per (ASTM C33):

   1. Fine aggregates: clean, sharp, natural sand.
   2. Coarse Aggregates: hard, sharp, angular, strong, clean, 3/4" maximum size stone meeting the requirements of New York State Department of Transportation Specification 703.02.

C. Water: Clean (not detrimental to concrete) and potable (ASTM C 94).

2.4 ADMIXTURES

A. Calcium Chloride in concrete is prohibited.

B. Air Entrainment Admixture: ASTM C260, Darex AEA ED or Architect approved equal.

C. Water Reducing Admixture: ASTM C494, Type A; not containing more chloride ions than are present in municipal drinking water.

D. High Range Water Reducing Admixture: ASTM C494, Type F or G; not containing more chloride ions than are present in municipal drinking water.

E. Cold Weather Accelerating Admixture: (Ambient temperature below 50°F.) Non-chloride water reducing accelerating admixture, ASTM C494, Type C, PolarSet as manufactured by WR Grace & Co. or Architect approved equal. Mix at rates recommended by the manufacturer. No reduction in compression rating of the concrete is permitted.

F. Hot Weather Water Reducing and Retarding Admixture: (Ambient temperature above 80° F.) Shall be Daratard series admixture, ASTM C494, Type D, as manufactured by WR Grace & Co. or Architect approved equal. Mix at a rate recommended by the manufacturer. No reduction in compression rating of the concrete is permitted.

2.5 RELATED MATERIALS

A. Expansion Joints:

   1. For Radius Applications: Expansion joint filler shall be polyethylene closed cell backing with peel off strip, X-Foam as manufactured by W.R. Meadows or Architect approved equal.

2. For Straight Applications: Expansion joint filler shall be fiber expansion joint with peel off snap-cap, as manufactured by W.R. Meadows or Architect approved equal.

B. Caulking for flat slabs shall be one part elastomeric self leveling polyurethane gray sealant Pourthane SL or Architect approved equal. Caulking for vertical surfaces shall be one component elastomeric gun grade polyurethane sealant Pourthane NS, color as selected by the Owner to match wall stain or Architect approved equal.

2.6 COMPOUNDS, HARDENERS, AND SEALERS for NON-TYPE 1L CEMENT MIXES

A. Water Based, Acrylic, Curing and Sealing Compound: ASTM C309, Type 1, Class A and B, clear or translucent. Standard of quality shall be VOCOMP-20 as manufactured by W.R. Meadows or Architect approved equal.

B. Water Based Penetrating Sealer: clear, penetrating, breathable, VOC-compliant, solvent free surface treatment for use on concrete to protect against water and chloride intrusion. Standard of quality shall be Protectosil 300 S as manufactured by Evonik Corporation or Architect approved equal.

2.7 COMPOUNDS, HARDENERS, AND SEALERS for TYPE 1L CEMENT MIXES

A. Curing, Sealing, and Protection System for Type 1L Cement Mix: Clear, penetrating, reactive, VOC-compliant system consisting of combined evaporation reducer, finish aid, curative, fixative, densifier, sealer agents to promote proper cure and produce mechanically and chemically densified power troweled concrete surfaces. Standard of quality shall be Emerald Concrete Control Series (Emerald Control, IceCore, and Emerald X) as manufactured by Green Umbrella Systems (greenumbrellasystems.com) or Architect approved equal.

2.8 CONCRETE MIX - GENERAL

A. Prepare design mixes for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both. Concrete mix designs shall conform to the requirements of ACI 301.

B. Cementitious Materials:

1. Use cementitious materials of the same brand and type and from the same manufacturing plant as those used in establishing the approved concrete mix design.

2. Fly ash or slag cement may be used as needed to reduce the total amount of Portland cement, which would otherwise be used, by not more than 15 percent. Notify concrete finishers of concrete material containing fly ash or slag cement.

a. Exception: Do not use fly ash or slag cement in any concrete mixtures for exterior concrete / slabs that will have moisture sensitive coating or finishes applied to the concrete.

C. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

D. Use aggregates from the same source and of the same size range as those used in the approved concrete mix design.

E. Admixtures: Use admixtures of the same brand and type as those used in the approved concrete mix design. Use admixtures according to the manufacturer's instructions.

F. Mix and deliver ready-mix concrete in accordance with ASTM C94.

1. Concrete must achieve stated minimum compressive strength at 28 days.
2. Concrete containing fly ash or slag cement must achieve stated minimum compressive strength at 56 days.

2.9 CONCRETE MIX – WALKS, SLABS, CURBS AND FOOTINGS

A. Concrete Mix:

1. Compressive Strength (Minimum at 28 days): 4,500 psi
2. Slump (Maximum): 4 inches +/- 1"
3. Air Entrainment: 6 – 8.5% +/- 1.5%
4. Flexural Strength (ASTM C78): 650 psi at 28 days.

B. Use water-reducing admixture in all concrete.

C. Water/Cement Ratio: Maximum 0.45 for 4,500 psi concrete.

D. Maximum Size of Coarse Aggregate:

1. General Work: Per ACI 301, 3/4" maximum.

E. Select admixture proportions for normal weight concrete in accordance with ACI 301.

F. Add air-entraining agent to concrete mix for all concrete work exposed to exterior.

2.10 CONCRETE MIX – STAIRS, RAMPS, AND RETAINING WALLS

A. Concrete Mix:

1. Compressive Strength (Minimum at 28 days): 5,000 psi
2. Slump (Maximum): 4 inches +/- 1"
3. Air Entrainment: 6 – 8.5% +/- 1.5%
4. Flexural Strength (ASTM C78): 650 psi at 28 days.

B. Use water-reducing admixture in all concrete.

C. Water/Cement Ratio: Maximum 0.40 for 5,000 psi concrete.

D. Maximum Size of Coarse Aggregate:

3. General Work: Per ACI 301, 3/4" maximum.

E. Select admixture proportions for normal weight concrete in accordance with ACI 301.

F. Add air-entraining agent to concrete mix for all concrete work exposed to exterior.

2.11 MIXING WATER CONTROL

A. The quantity of mixing water used in the concrete mix shall be determined by the Contractor, except that the Architect/Geotechnical Engineer may direct that such quantity of water be reduced if the slump of the concrete exceeds the specified slump. The Contractor's determination of the quantity of mixing water shall conform to the various limits on water/cement ration and slump specified. Concrete consistency shall be uniform from batch to batch.

B. During the course of the work, the batch plant will make quantitative measured moisture determinations of the aggregates utilized in each batch. Aggregate weights and batch water requirements shall be adjusted accordingly for measured aggregate moisture content.

C. When concrete is transported in units approved for mixing, the addition of not more than 10% of the total design water will be permitted at the job site to obtain initial slump.

1. Any addition of water shall be followed by mixing of at least 30 revolutions in the mixing speed range.
2. No more than two additions of water at the point of deposition before discharge shall be allowed.
3. No retempering of the concrete will be permitted. Retempering is defined as the addition of water after the mix has attained its desired initial slump.

2.12 EXTERIOR ANCHORING CEMENT (NON-SHRINK GROUT)

A. For Steel Posts, Fencing and Other Non-Aluminum Elements: Shall be an exterior grade anchoring cement (non-shrink grout) with a min. compressive strength (ASTM C-109) of 7,200 psi at 28 days. Standard of quality shall be Super Por-Rok as manufactured by CGM, Inc., www.cgmbuildingproducts.com, or Architect approved equal.

B. For Aluminum Posts and Elements: Shall be an exterior grade anchoring cement (non-shrink grout) with a min. compressive strength (ASTM C-109) of 7,200 psi at 28 days. Standard of quality shall be Por-Rok as manufactured by CGM, Inc., www.cgmbuildingproducts.com, or Architect approved equal.

2.13 HIGH STRENGTH ANCHORING EPOXY SYSTEM

A. A two-component vinylester adhesive anchoring system. The system includes injection adhesive in plastic cartridges, mixing nozzles, dispensing tools and hole cleaning equipment.

B. Designed for bonding threaded rod and reinforcing bar elements into drilled holes in concrete and masonry base materials.

C. Standard of quality shall be AC100+ GOLD Vinylester Injection Adhesive Anchoring System as distributed by A.H. Harris, (315) 414-0340, or Architect approved equal.

2.14 CONCRETE BONDING AGENT

A. Shall be a concrete bonding adhesive specifically formulated for permanently bonding new concrete to old concrete in exterior applications.

B. Concrete bonding adhesive applied to appropriate substrates will achieve tensile bond strengths typical of 150 psi in 28 days.

C. Standard of quality shall be Quickrete Concrete Bonding Adhesive or Architect approved equal.

PART 3 - EXECUTION

3.1 CONCRETE WALKS, PADS, AND RAMPS

A. Surface Preparation: Remove loose material from the compacted subgrade surface immediately before placing concrete. Remove any standing water, mud, debris, frost, snow, ice from surfaces upon or against which concrete is to be placed.

B. Proof-roll prepared subgrade surface to check for unstable areas and the need for additional compaction. Do not begin concrete pour until such conditions have been corrected, subgrade is compacted to 95% and ready to receive concrete.

C. Form Construction: Construct to required size and shape. Brace and secure to maintain alignment, elevation and position. Check completed formwork for grade and alignment, prior to installing concrete. Clean forms as needed to removed foreign matter.

D. Install welded wire mesh on concrete brick or mesh chairs to proper level in maximum lengths possible. Offset end laps in both directions. Splice laps with tie wire. Lifting mesh after concrete pouring is not acceptable.

E. Prepare concrete mixture including the following:

1. Add hot weather or cold weather admixture to accommodate field weather conditions.

F. Concrete Testing: Will be performed as described in Part 3, "Field Quality Control" of this specification section.

G. Conveying:

1. Convey concrete by means that will prevent segregation and loss of mortar form the mix.
2. Provide adequate manpower and equipment in the form of buckets, buggies, chutes, conveyors or other approved means to assure continuous operation.
3. Convey concrete so that no equipment with aluminum parts comes in contact with fresh concrete.

H. Concrete Placement: Do not place concrete until subgrade and forms have been checked for line and grade. Moisten granular base course as required to provide a uniform dampened condition at the time concrete is placed. Do not place concrete around manholes or other structures until they have been brought to the required finish grade, alignment, and expansion joints have been installed.

I. Spread concrete as soon as it is deposited on the granular base course, using methods which prevent segregation of the mix, and with as little rehandling as possible. Consolidate concrete along the face of forms. Consolidate with care to prevent dislocation of mesh, reinforcing and joint materials.

J. Install Concrete Walk Joints:

1. Construct expansion and contraction joints as detailed and as shown on plans. Concrete joints that do not follow the pattern(s) shown on the plans and/or changes that have been approved by the Architect will be removed and replaced at no additional cost to the Owner.
2. When the walkway is abutting existing walks, place transverse joints to align with previously placed joints, unless otherwise shown.
3. Contraction Joints: Approximately 5' on center. Break walk into individual slabs of not more than twenty-five (25 sf) square feet with jointing tool, round edges. Saw cut scoring pattern (contraction joints) to depth shown on details for each type of concrete work with new, sharp concrete sawblade one day (24 hours) after the pour. Joint cuts to be clean, sharp, uniformly made cuts to achieve scoring pattern as shown and detailed. Note: When tooled joints or saw cutting is not performed as described, an extended three (3 yr.) year written guarantee or credit for defective work will be required as determined by the Architect at no additional cost to the Owner.
4. Expansion Joints: Provide where abutting building(s), columns, structures, concrete paving and curbs, catch basins, manholes, inlets, walks, walls, other fixed objects and as directed by the Architect.
5. Locate expansion joints at thirty feet on center (30' o.c.) for each walkway lane, unless otherwise shown. Provide slip dowels as detailed and specified.
6. Locate expansion joints with slip dowels at all flush building access points, whether specifically shown on drawings or not.
7. Extend joint fillers full width and depth of the joint, flush with finished pavement grade, and not less than 1/4" or more than 1/2" below the finished pavement surface. Joint surfaces shall be clean and dry prior to installation of sealant as per manufacturer's recommendations. Remove excess sealant on surfaces adjacent to joint.

K. Concrete Finishing:

1. Perform concrete finishing using machine or hand methods as required.
2. After striking off and consolidating concrete, smooth the surface by screeding and floating. Use hand methods only where mechanical floating is not possible. Adjust the floating to compact the surface and produce a uniform texture.
3. After floating, test surface for trueness with a ten (10') foot straightedge. Distribute concrete as required to remove surface irregularities, and refloat repaired areas to provide a continuous, smooth finish.

4. Work edges of slabs and joints with a 1/8" radius edging tool, two (2") wide, unless otherwise shown.
5. After completion of floating and when excess moisture or surface sheen has disappeared, complete surface finishing, as follows.
6. Broom finish, by drawing a medium hair broom across the concrete surface as detailed. Repeat operation when required to provide a medium texture acceptable to the Architect.
7. For handicap curb ramps, tool grooves along sloping surfaces in line with drainage flow as detailed.

L. Concrete Curing and Sealing Non-Type 1L Cement Mixes:

1. Refer to schedule note in 1.6 Job Conditions above.
2. Immediately after placement, protect concrete from premature drying.
3. Remove all dirt, dust, oil, grease, asphalt, vegetation, grass, and foreign matter. Cleanse with caustics and detergents as required. Rinse thoroughly and allow to dry.
4. Stir curing compound thoroughly before using.
5. Apply a continuous, uniform film by solvent-resistant low-pressure spray only, short-nap roller or lamb's wool applicator. For best results, use a canister curing compound sprayer. Use spray tip number 8004 or equivalent for water-based or waterborne products.
6. For curing, coat evenly and uniformly as soon as possible after final finishing.
7. Apply penetrating sealer minimum thirty (30) days after application of curing compound when all construction is completed and structure is ready for occupancy / use, prior to any application of de-icing chemicals. Following manufacturer’s recommendations for application over concrete including removing any remaining curing products.
8. When soil contamination occurs, notify the Architect immediately in writing. Remove contaminated soils and legally dispose of, provide soil test(s), replace soil, plantings and lawns at no additional cost to the Owner.

M. Concrete Curing and Sealing Type 1L Cement Mixes:

1. Refer to schedule note in 1.6 Job Conditions above.
2. Follow Emerald Concrete Control Series Application Guide. Do NOT skip any required step as directed. Do NOT reuse sprayers between steps.
9. Immediately after screed apply Emerald Control at 800 sf per gallon with sprayer, continue finishing as detailed and specified.
10. Once slab is walkable and finishing is complete install IceCore at a rate of 500 sf per gallon.
11. Wait 48 hours after pour, once slab is dry and clean install Emerald X at a rate of 800 sf per gallon. Keep concrete clean of ANY traffic for 24 hours minimum.

12. When soil contamination occurs, notify the Architect immediately in writing. Remove contaminated soils and legally dispose of, provide soil test(s), replace soil, plantings and lawns at no additional cost to the Owner.

3.2 CONCRETE CURB

A. General: Concrete Curb shall meet the requirements specified for concrete in this Section, Item 3.1 above. Install forms true to line and grades given on plan. Provide permanent in place expansion joints using pre-molded expansion joint filler thirty feet (30' o.c.) on center, maximum. Install reinforcing bars as detailed. Remove forms in twenty-four (24) hours. Saw cut the contraction joints approximately 10' on center 1-1/2" deep with a new sharp concrete saw blade the next day after the pour along top and both faces of curb. Note: When the saw-cutting is not performed as described, an extended written guarantee or credit for defective work will be required by the Architect.

B. Finishing: Remove ties and patch tie holes, including those below grade. Remove fins and patch minor voids. Chip out major stone pockets and repair. Rub surface smooth with carborundum brick dipped in neat cement grout to fill pin holes. Trowelled on cement plaster is prohibited. After drying, rub off excess cement dust with burlap.

C. Curing: See 3.1, above.

D. Slip-formed (machine formed) curbs are acceptable when installed in accordance with NYSDOT 609-3.04-B using Type "J" concrete and mixing in fiber mesh as specified. Expansion and contraction joints are still required as detailed including slip dowels at expansion joints.

3.3 CONCRETE STAIRS

A. General: Concrete stairs shall meet the requirements specified for concrete in this Section, Item 3.1, except as noted below.

B. Verify that lines, levels, locations and form dimensions comply with drawings and submittals.

C. Design, erect, support, brace, and maintain formwork to support applied vertical and lateral loads. Construct formwork to provide correct size, alignment, elevation, pitch on tread, and position of concrete work.

D. Design and erect formwork to permit removal without damage to cast-in-place concrete surfaces and adjacent materials during stripping.

E. Install, align, and level forms. Support and brace forms in place.

F. Coat form surfaces with form release agent. Clean forms after each use and coat with form release agent as necessary to assure separation from concrete without damage. Apply before placing reinforcing steel, anchoring devices, and embedded items.

G. Provide reinforcing bars adequately supported and secured to prevent displacement.

H. Placement of concrete shall be in layers not to exceed 18 inches without consolidation with the aid of mechanical vibrating equipment. To achieve even and dense surfaces, free of aggregate pockets or honeycomb, vibration shall be supplemented by spading by hand in the corners and angles of forms and along surface while concrete is plastic under the vibratory action. Placement of concrete shall conform to recommendations of ACI 309 "Recommended Practice for Consolidation of Concrete".

I. Install, set, and build-in items furnished by other trades. Provide adequate notification for installation of necessary items. Coordinate with reinforcing, safety railings and hand railings.

J. Remove ties and patch tie holes, including those below grade. Remove fins and patch minor voids. Chip out major stone pockets and repair. Rub surface smooth with carborundum brick dipped in neat cement grout to fill pin holes. Trowelled on cement plaster is prohibited. After drying, rub off all excess cement dust with burlap.

K. Medium broom finish stair treads with strokes perpendicular to flow of pedestrian traffic, similar to walks. Other exposed concrete surfaces shall be rub finished similar to concrete curb.

L. Cure and seal as specified in this section, item 3.1 above.

M. Strip Forms and Bracing: Three (3) days minimum before stripping. It is the Contractor's responsibility to determine the time at which forms may be removed without damaging the stairs and only after concrete has gained sufficient strength to carry its own weight and imposed loads.

3.3 CONCRETE RETAINING WALL(S)

A. General: Concrete retaining wall(s) shall meet the requirements specified for concrete in this specification section, Item 3.1, except as noted below.

B. Verify that lines, levels, locations and form dimensions comply with drawings and submittals.

C. Design, erect, support, brace, and maintain formwork to support applied vertical and lateral loads. Construct formwork to provide correct size, alignment, elevation, pitch on tread, and position of concrete work.

D. Design and erect formwork to permit removal without damage to cast-in-place concrete surfaces and adjacent materials during stripping. Thoroughly clean forms and adjacent surfaces to receive concrete. Remove sawdust, dirt or other debris before placing concrete. Tighten forms and bracing to prevent mortar leaks and maintain proper alignment.

E. Install, align, and level forms. Support and brace forms in place. Provide watertight joints, sealed to prevent leakage. Rustication strips are recommended at construction joints or between pours. Chamfer exposed corner and edges as detailed, using wood, metal PVC or rubber chamfer strips fabricated to provide uniform smooth lines and tight edge joints.

F. Provide reinforcing bars adequately supported and secured to prevent displacement. Splices in reinforcing bars shall conform to ACI 318 and stagger splices wherever possible.

G. Seams: Liner butt joints shall be carefully blended into the approved pattern. No visible vertical or horizontal seams or conspicuous marks created by butt jointing form liners will be allowed. Work to conform to approved sample.

H. Placement of concrete shall be in layers not to exceed 18 inches without consolidation with the aid of mechanical vibrating equipment. To achieve even and dense surfaces, free of aggregate pockets or honeycomb, vibration shall be supplemented by spading by hand in the corners and angles of forms and along surface while concrete is plastic under the vibratory action. Placement of concrete shall conform to recommendations of ACI 309 "Recommended Practice for Consolidation of Concrete".

I. Install, set, and build-in items furnished by other trades. Provide adequate notification for installation of necessary items. Coordinate with reinforcing, safety railings and hand railings.

J. Strip Forms and Bracing: Stripping form liners shall be done within three (3) days. It is the Contractor's responsibility to determine the time at which forms may be removed without damaging the walls or weakness to the substrate and only after concrete has gained sufficient strength to carry its own weight and imposed loads.

K. Install drainage behind wall and retaining wall granular backfill to 95% compaction behind wall as detailed and specified in Section 312201.

L. Patches: Fill tie holes and defects in concrete surface within 48 hours of form removal. Use the same patching materials and techniques that were approved on mockup. Make patches with a still mortar made with materials from the same sources as the concrete. Adjust mortar mix if necessary to lighten it.

M. Rough-Formed Finish: Provide a rough-formed finish on formed concrete surfaces NOT exposed to view in the finish work or concealed by other construction.

N. Smooth-Formed Finish: Provide a smooth-formed finish on formed concrete surfaces to view or to be covered with a coating or covering material applied directly to the concrete, such as waterproofing, veneers or painting. Repair and patch defective areas with fins and other projections.

O. Rubbed-Finish:

1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one part Portland cement to one and one-half parts fine sand with a 1:1 mixture of bonding admixture and water. Add white Portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 26 hours.

P. The surface shall be sealed with the approved sealer, per manufacturer’s instructions, as approved by the Owner.

3.3 FOOTINGS, BASES, AND FOUNDATIONS

A. Footings, Bases, Foundations: Locate and provide where shown on drawings and as detailed.

3.4 INTERRUPTION OF CONCRETING

A. Should placing concrete be suspended or unavoidably interrupted, provide key ways and bulkheads to prevent feather-edging when work is resumed. Roughen horizontal surface for bond.

3.5 REPAIR AND PROTECTION FOR CONCRETE WORK

A. Cut out and replace defective concrete work which has blisters, cracking, crazing, curling, discoloration, dusting, efflorescence, low spots, pop outs, scaling or mortar flaking, spalling, settling, or heaving as defined by Portland Cement Association 2001, "Concrete Slab Surface Defects" and as directed by the Architect.

B. Modify or replace concrete not conforming to the required lines, details, elevations and specifications as directed by the Architect.

C. Protect the work from damage until acceptance of the work. Exclude traffic from concrete work for at least fourteen (14) days after placement. When construction traffic is permitted, maintain concrete as clean as possible by removing surface stains and spillage of materials as they occur.

3.6 ANCHORING RAILINGS AND POSTS INTO CONCRETE

A. Aluminum posts **must** be coated or treated with a good sealer or paint prior to anchoring.

B. Drill the hole as detailed. Blow out all dust and loose particles.

C. Fill the hole with water. Scrub the sides and bottom of the hole and with a stiff wire brush such as a bottlebrush. This is important.

D. Remove excess water with rag or other absorbent materials. Leave the hole clean and uniformly damp.

E. Mix the anchoring cement in a clean container to flowable consistency based on the following formula. For best results, measure accurately. The correct amount of water is as follows:

2.3 oz per lb
11.5 oz for 5 lbs
115 oz for 50 lbs
7 quarts for 100 lbs

Measure the amount of anchoring cement and water to be mixed. Add the measured amount of water to the appropriate amount of cement and mix until the desired consistency is achieved. (NEVER USE MORE WATER THAN PRESCRIBED). This will reduce the ultimate strength, increase the possibility of volume instability and may cause the product to become soft and less durable.)

F. Fill the hole with the plastic cement first, and then tamp the bolt, post or rod with a twisting motion into place. If the material becomes too fluid during the tamping process and sags out of place, let it stand for a few minutes and it will stiffen. Smooth out the surface around the bolt with spatula or trowel.

G. Let the cement harden for at least 60 minutes. For heavy equipment, allow 4 hours prior to use or loading.

3.7 ANCHORING BOLTS, DOWELS, AND REBAR INTO CONCRETE

A. Anchor Hole Preparation: Prepare all anchor holes prior to placement of anchoring epoxy. Hole diameter is typically 1/8" (3 mm) greater than the anchor diameter. Hole depth is typically nine times anchor diameter. Required minimum anchor hole depth is 6". Consult project specifications and details. Drill hole to proper diameter and depth and blow all dust from the bottom of the hole, brush and blow (4x) repeatedly to remove all dust and debris. The anchor hole must be clean and free of standing water prior to placement of material.

B. Application: Use only professional caulking gun. Remove plastic cap and plugs from cartridge. Save for closing cartridge. Attach mixing nozzle to cartridge. Discard small amount of gunned product until uniform color is achieved. Mixing nozzle will harden in approximately 20 min. if not in use.

C. Hardened nozzle must be discarded. Dispense the epoxy at the bottom of the hole while withdrawing nozzle. Dispense epoxy (typically filling 5/8 of hole) so that once threaded rod or rebar is inserted, the hole is completely full. Insert threaded rod or rebar to the bottom of the hole while turning clockwise. Promptly remove any excess material. Leave anchor undisturbed for 6 hours (at 77°F /25°C), or longer for colder temperatures. Load can be applied 8 hours at 77°F (25°C).

3.8 CONCRETE BONDING AGENT

A. Required at elements where new concrete is applied and joined to existing concrete.

B. Surface Preparation:

1. Apply only to clean, sound, dry surfaces.
2. Remove dust, dirt, oil, grease, wax, unsound concrete and plaster, paint, and other foreign materials.

C. Applications:

1. Apply to a dry surface with brush, roller or spray to the thickness of a coat of paint.
2. Place new concrete, topping mixes, Portland cement, or patches as soon as the adhesive is dry.
3. Make sure basecoat is dry before applying adhesive.
4. Tools, brushes and other application accessories should be immediately cleaned with soapy water. Use hot water to clean up any drippings.

3.9 FIELD QUALITY CONTROL

A. Field inspection and testing shall be performed by ACI certified technicians; Grade 1. Certificates shall be submitted to the Architect for persons performing inspection and testing prior to the start of work.

B. Field Inspection and testing shall be paid for as directed under 1.5 "Quality Assurance". Where retesting, additional inspection, lab tests or other professional services are required due to rejected work, any cost associated therewith will be solely at the Contractor's expense.

C. The Contractor shall plan his operations to allow adequate time for all required testing and inspection.

D. The Contractor shall provide facilities and equipment necessary to obtain and handle representative sample of materials to be tested.

E. The testing laboratory shall be responsible to the Owner for the field control of all concrete and may reject batches because of high slump, uncontrolled air entrainment, delays or other conditions of non-compliance with these specifications.

F. Sampling and Field testing will be performed during concrete placement per ASTM C31, C39, C143, C172 and C173.

G. Five (5) Concrete Test Cylinders: Taken for every 30 or less cubic yards of concrete placed are required or a fraction thereof;

1. Two (2) Cylinders will be tested at 7 days, two (2) cylinders will be tested at 28 days and one (1) cylinder will be held for possible testing at a later time.

H. One (1) Additional Test Cylinder: Taken during cold weather concreting, to be cured on the job site under the same conditions as placed concrete it represents, is required.

I. Air Content Test: Taken for each set of test cylinders taken, is required.

J. One (1) Slump Test: Taken for each set of test cylinders taken is required.

K. Test results will be reported by telephone to the General Contractor and Architect on same day tests are made. Written report with copies will follow to the Owner, Architect, and Landscape Architect. Email copies of laboratory test, evaluation reports for concrete materials and mix designs will be submitted.

3.10 CLEAN UP

During the contract and at intervals as directed by the Architect and as concrete work is completed, clear the site of gravel, concrete, appurtenances and debris. Leave the site in a clean, safe, well draining, neat condition.

END OF SECTION 321301

SECTION 321302 - CONCRETE REPAIR WORK

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. The extent of concrete repair work is shown on the drawings and includes surface preparation, cleaning, bonding agents, concrete repair mortar, finishing, curing, protection, and acceptance requirements for concrete repair.

B. Concrete repair work includes, but is not limited to, the following:

1. Concrete repair - horizontal/vertical
2. Clean up

C. Provide materials, labor, equipment and services required to accomplish related work in accordance with the drawings and specifications.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 311201 - Site Preparation

B. Section 321301 - Site Concrete work

1.3 REFERENCES

A. ASTM C109 Standard Test Method Used for Compressive Strength of Hydraulic Cement Mortars.

B. ASTM C150 Standard Specification for Portland Cement.

1.4 SUBMITTALS: (See Section 311201, 1.5)

A. Materials certificates required for the following: Provide MPD and samples as noted.

1. Concrete repair mortar for horizontal/vertical surfaces

1.5 JOB CONDITIONS

A. Job conditions in Section 311201 apply. Provide ample and skilled manpower for concrete repair work which is a recognized time sensitive procedure.

B. Do not install concrete work when the temperature of the outside air is below 40 degrees F. and falling unless suitable means acceptable to the Architect are provided to protect work from cold and frost and ensure that mortar and concrete will cure without freezing.

C. Construction Review: Notify the Architect when repair areas are cleaned and ready to receive concrete repair product(s).

PART 2 - PRODUCTS

2.1 CONCRETE REPAIR MATERIALS

A. Shall be a one-component, shrinkage-compensated, very rapid-setting Portland cement-based, non-gypsum based concrete, designed for horizontal and vertical concrete surfaces where high early strength gain is required.

B. Standard of quality shall be Ardex CD Fine as manufactured by Ardex and distributed by A.H. Harris or Architect approved equal.

C. Color and texture shall match existing concrete.

2.2 CONCRETE SEALER

A. Standard of quality shall be Ardex CG Concrete Guard or Architect approved equal.

PART 3 - EXECUTION

3.1 CONCRETE SURFACE REPAIR

A. Substrate Preparation: All concrete substrates must be structurally sound, solid, thoroughly clean and free of any form release, sealers or paints, patching compounds, dust , dirt , oil, and any other contaminant that could act as a bond breaker. If necessary, mechanically clean the existing horizontal surface down to sound, solid concrete by shot blasting, sandblasting, scarifying or grinding. High-pressure (5000 psi) power washing may also be used to remove contaminates, vegetation, and weak surfaces, though the concrete must then be allowed to dry thoroughly before proceeding. Overwatered, frozen or otherwise weak concrete surfaces must also be cleaned down to sound, solid concrete by mechanical methods. Acid etching, adhesive removers, solvents and sweeping compounds are not acceptable means of cleaning the substrate. The use of sanding equipment is not an effective method to remove curing and sealing compounds. Clean debris out of expansion joints and tape or mask the joints off to prevent from filling the joint. Use a lawn edger to clean around walks or driveways, as well as around planters, lawns and vegetated areas. Substrate and ambient temperatures must be a minimum of 50 degrees F. for the installation product.

B. Mixing and Application:

1. For one 20 lb bag of product, use 2-1/2 quarts of clean water. Pour water in the mixing container first, and then add the product. To mix smaller quantities by hand, use 2.75 parts powder to 1 part of water by volume. DO NOT OVERWATER. Use a margin trowel and mix vigorously for 2 to 3 minutes. For best result, mix with a ring mixing paddle and ½" heavy-duty drill. Mix thoroughly to obtain a lump-free consistency.

2. The pot life is approximately 30 minutes at 70 degrees F. If the product begins to set in the bucket within this time, remix before using. DO NOT ADD MORE WATER. In warm weather, use cold water to extend the working time.

3. Pour the mix onto an area of concrete and flat trowel, squeegee or broom it onto the surface while applying enough pressure to ensure good dressing-to-concrete contact. Maintain a "wet edge" during installation to help minimize natural color

variations that can occur between sections. Immediately apply a light broom finish to achieve the desired texture, working in areas small enough to permit finishing without walking on the freshly installed dressing.

4. On vertical surface such as walls or stair faces, trowel, brush or spray the dressing using a hopper gun directly onto the prepared area. Smooth or brush the material to the desired finish.

5. For minor patching, filling small holes, gouges or spalls (up to 1" diameter and ½" deep), mix 4 parts powder to 1 part water by volume and apply to the prepared surface with a flat steel trowel or putty knife. Repair areas should be allowed to set firmly (30 to 45 min. at 70 degrees F.)before applying the finish coat of the dressing. Cool ambient and surface temperatures will slow setting time.

C. Thickness of Application: To be installed in as thin a layer as can be placed while getting full coverage. Typical installation thickness ranges from, 1/32" up to 1/8" and can be applied at a thickness of up to ½" in small, well-defined areas. Please note the thicker areas will take longer to set than a dress coat, and will reduce the overall coverage.

D. Curing: Requires no special curing procedures. Avoid applying this product if rain is expected within 6 to 8 hours or freezing temperatures could occur with 24 hours of application. As with any cementitious material, these conditions can alter the appearance and performance of the dressing.

E. Color: Formulated from Portland cement and is available in gray or white. As concrete color and jobsite conditions vary widely, it is not intended that either of these will match the color of the concrete being resurfaced or an adjacent concrete pad. Jobsite conditions such as direct sunlight with wind, as well as the surface of the dressing being exposed to moister before it completely sets, can lead to color variations in the appearance of the dressing. Should this occur, it can often be completely corrected by pre-wetting the surface of the discolored dressing and misting it with a vinegar solution diluted with 3 parts of water. Allow vinegar to stand on the surface for a minimum of 10 minutes without allowing it to dry. Rinse clean and allow to dry thoroughly. Should the condition persist, the use of a pigmented seal may be required.

F. Concrete Repair Surfaces: Shall be sealed with a waterborne, breathable concrete sealer to prevent dusting and to help resist damage from standing water, salt and oil, as well as staining and marking. Seal as soon as the dressing hardens sufficiently to work on without damaging the surface.

3.2 CLEAN UP

During the contract and at intervals as directed by the Architect and as concrete repair work is completed, clear the site of aggregate, mortar, appurtenances and debris. Leave the site in a clean, safe, well draining, neat condition.

END OF SECTION 321302

SECTION 321303 – CONCRETE COATING SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. The extent of concrete coating system work work is shown on the drawings and includes crack repair, urethane sealant, and elastomeric coating for pedestrian traffic applications.

B. Concrete coating system work includes, but is not limited to, the following:

1. Repair and elastomeric coating of existing concrete
2. Clean up

C. Provide materials, labor, equipment and services required to accomplish related work in accordance with the drawings and specifications.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 321301 - Site Concrete

1.3 REFERENCES

A. ASTM C 920 – Standard Specifications for Elastomeric Joint Sealants

B. ASTM C 957 – Standard Specification for High-Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane with Integral Wearing Surface

C. ASTM C 1127 – Standard Guide for Use of High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane with an Integral Wearing Surface

D. ASTM C 1193 Standard Guide for Use of Joint Sealants

E. ASTM D 4258 – Standard Practice for Surface Cleaning Concrete for Coating.

F. ICR 310.2R – Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair.

G. SWR Institute Validation Program

H. UL 790 – Standard Test Methods for Fire Tests of Roof Coverage.

1.4 SUBMITTALS: (See Section 311201, 1.5)

A. Shop Drawings required for:

1. Identify locations for traffic coating system components. Show details for each type of substrate, corners, and edge conditions, transitions, and terminations.

B. Manufacturers Product Data (MPD) and Samples where indicated are required for the following:

1. Traffic Coating Products.
2. Joint Sealant.

C. Qualification Data: For installer, manufacturer, and traffic coating inspector.

D. Product Test Reports: Test data for traffic coating products and traffic coating system, by qualified testing agency, indicating proposed traffic coating meets performance requirements, when requested by Architect.

E. Warranty: Sample of unexecuted manufacturer and installer special warranties.

F. Field quality control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A manufacturer approved firm with minimum five (5) years' experience in installation of specified products in successful use on similar projects, employing workers trained by manufacturer, including a full-time on-site supervisor with a minimum of three (3) years' experience installing similar work, and able to communicate verbally with Contractor and employees.

B. Manufacturer Qualifications: A qualified manufacturer with minimum five (5) years' experience in manufacture of traffic coating as one of its principal products.

1. Manufacturer's product submitted has been in satisfactory operation on five (5) similar installations for at least five (5) years.

2. Approval of Manufacturers and Comparable Products: Submit the following in accordance with project substitution requirements, within time allowed for substitution review:

a. Completed and signed Substitution Request Form.
b. Product Data, including certified independent test data indicating compliance with requirements.
c. Sample shop drawings from a similar project.
d. Project References: Minimum of five (5) installations of similar system not less than five years old, with Owner and Architect contact information.
e. Name and resume of proposed qualified inspector.
f. Sample Warranty.

C. Testing Agency Qualifications: Qualified independent agency experienced in the installation of the specified traffic coating system, and qualified to perform observation and inspection specified in Field Quality Control Article to determine installer's compliance with the requirements of this Project as employed by the Owner.

D. Mockups: Provide traffic coating mockup application within mockups required in other sections, or if not specified, in an area of not less than 100 square feet of surface where directed by Construction Manager for each type of substrate condition. Include examples of surface preparation, crack and joint treatment, traffic coating application, slip-resistant

aggregate application, and flashing, transition, and termination conditions, to set quality standards for execution.

1. Include intersections of deck traffic coating with adjacent vertical coating and moisture control system applications.

E. Conform to New York State Building Code.

1.6 JOB CONDITIONS

A. Job conditions in Section 312201 apply. Provide ample and skilled manpower for traffic coating application.

B. Store products in weather protected environment, clear of ground and moisture, within temperature ranges recommended by traffic coating manufacturer.

C. Construction Review: Notify the Architect when surfaces have been prepared to receive traffic coating for inspection.

D. Environmental Requirements: Apply traffic coating within the range of ambient and substrate temperatures recommended by traffic coating manufacturer.

1. Protect substrates from environmental conditions that affect coating performance.

2. Do not apply traffic coating to a damp or wet substrate or during snow, rain, fog, or mist or when dew is present.

E. Scheduling: Coordinate installation of traffic coating with completion of other work requiring interface with traffic coating. Schedule work so traffic coating applications may be inspected by Architect prior to concealment.

1.7 WARRANTY

A. Special Manufacturer's Warranty: Manufacturer's standard form in which traffic coating manufacturer agrees to furnish traffic coating material to repair or replace those materials installed according to manufacturer's written instructions that exhibit material defects or otherwise fail to perform as specified under normal use within warranty period specified.

1. Access for Repair: Owner shall provide unimpeded access to the Project and the traffic coating system for purposes of testing, leak investigation, and repair, and shall reinstall cladding and overburden materials upon completion of repair.

2. Warranty Period: 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Provide traffic coating products manufactured by Tremco, Inc., Commercial Sealants and Waterproofing Division, AN RPM Company, Beachwood OH; (866) 321-6357; www.tremcosealants.com or architect approved equal.

B. Provide traffic coating system materials and accessory products from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. General: Traffic coating system shall be capable of performing as a continuous watertight installation and as a moisture drainage plane transition to adjacent flashings and discharging water to the structure exterior. Traffic coating shall accommodate normal substrate movement and seal expansion and control joints, construction material transitions, opening transitions, penetrations, and perimeter conditions without resultant moisture deterioration.

B. Comparability: Provide traffic coating system materials that are compatible with one another and with adjacent materials under conditions of sever and application required, as demonstrated by traffic coating manufacturer based on testing and field experience.

2.3 TRAFFIC COATING FOR PEDESTRIAN TRAFFIC

A. Traffic Coatings: Manufacturer's standard exposure, pedestrian traffic-bearing, seamless, high-solids0content, cold liquid-applied, elastomeric waterproofing membrane system meeting ASTM C 957, and SWRI validated. Standard of quality shall be Tremco, Inc., Vulkem 350NF / 351, or Architect Approved Equal.

B. Primer. Liquid primer recommended for substrate and conditions by traffic-coating manufacturer.

C. Base Coat: Aromatic Polyurethane.

D. Topcoat: Aliphatic Polyurethane with UV inhibitors. Color: Provide color samples for owner selection.

E. Topcoat Aggregate: Manufacturer's standard aggregate for each use indicated of particle sizes, shape, and minimum hardness recommended in writing by traffic-coating manufacturer.

2.4 ACCESSORY MATERIALS

A. General: Accessory materials as described in manufacturer's written installation instructions, recommended to produce complete traffic coating system meeting performance requirements, and compatible with traffic coating material and adjacent materials.

B. Single -Component, Non-Sagging Polyurethane Joint Sealant: ASTM C 920, Type NS, Class 50. Standard of quality shall be Tremco Inc., Dymonic 100 or Architect Approved Equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Surface Condition: Before applying traffic coating materials, examine substrate and conditions to ensure substrates are fully cured and few from high spots, depressions, loose and foreign particles and other deterrents to adhesion, and conditions comply with manufacturer's written recommendations.

1. Verify concrete surfaces are visibly dry, have cured for time period recommended by manufacturer, and are free from release agents, curing agents, laitance, and other contaminants.

2. Test surfaces following cleaning and abrasion specified below.

a. Test for capillary moisture by method recommended in writing by traffic-coating manufacturer.
b. Test for traffic coating adhesion per manufacturer's recommended method.
c. Notify Architect in write if unusual or unsatisfactory conditions are discovered.

B. Proceed with installation once unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean, prepare, and treat substrates in accordance with ASTM C 1127 and traffic coating manufacturer's written instructions.

1. Remove contaminants, curing compounds, and film-forming coatings from substrates.

2. Remove projections and excess materials and fill voids with manufacturers recommended substrate patching material.

3. Prepare surfaces toa uniform profile in accordance with ASTM D 4259 and meeting ICRI Surface Profile CSP 2-4. Do not acid etch.

4. Clean prepared surfaces in accordance with ASTM D 4258.

B. Protect adjacent finished surfaces by masking. Mask termination point on vertical surfaces. Protect weep holes and drains.

3.3 TERMINATIONS AND PENETRATIONS

A. Detail Preparation: Prepare vertical and horizontal surfaces at horizontal to vertical transistions, terminations, joints, and penetrations through traffic coatings in accordance with ASTM C 1127 and manufacturer's written instructions, using accessory materials specified.

1. At terminations of traffic coating exposed to traffic, rout ¼" x ¼" keyway in concrete.

2. Prepare non-moving shrinkage cracks, large cracks, constriction joints, expansion joints, projections and protrusions, penetrations, drains, and changes in plane in accordance with manufacturer's written instructions and details.

3. Prepare joints and cracks in substrate in accordance with ASTM C 1127 and ASTM D 4258 and manufacturer's written instructions.

B. Joint Sealant Installation: Comply with ASTM C 1193 and manufacturer's written instructions. Allow joint sealants to cure adequately before coating with traffic coating.

1. Provide joint sealant cants with backer rods at penetrations and at horizontal-to-vertical intersections. Tool sealant material to form 45 degree angle transition.

2. Rout and fill cracks with joint sealant and tool flush with surface.

3. Feather edges of joint sealant applications.

4. Allow joint sealant to cure. Apply detail coat of base coat over unfilled and filled cracks and joints, and feather terminating edges.

5. Fill expansion joints with backer rod and joint sealant Do not apply traffic coating over expansion joints.

3.4 PEDESTRIAN TRAFFIC-COATING APPLICATION

A. Primer: Prime metal surfaces, porous surfaces (when required), and preceding coats left uncoated for more than 24 hours or that have lost surface tack, with manufacturer's recommended primer. Allow to cure before proceeding.

B Apply traffic coating according to ASTM C 1127 and manufacturer's written instructions. Use roller-applied or self-leveling formulations as recommended by manufacturer for project conditions.

1. Verify that wet film thickness of each coat complies with requirements every 100 square feet.

C. Apply number of coats of specified compositions for pedestrian traffic coating at locations indicated on drawings.

1. Base Coat: Single application of not less than 40 mil.

2. Top Coat: Single applications at not less than 15 mil.

3. Aggregate: Uniformly broadcast aggregate on coats specified to receive aggregate. Embed aggregate according to manufacturer's written instructions.

D. Apply traffic coatings to prepared wall terminations and vertical surfaces to height indicated; omit aggregate on vertical surfaces.

E. Cure traffic coatings. Prevent contamination and damage during application and curing stages.

3.5 CLEANING AND PROTECTING

A. Clean spills, stains, and overspray resulting application utilizing cleaning agents recommended by manufacturers of affected construction. Remove masking materials.

B Protect traffic coating from damage from subsequent work. Protect traffic coating materials from exposure to UV light for period in excess to that acceptable to traffic coating manufacturer; replace overexposed materials and retest.

3.6 CLEAN UP

During the contract and at intervals as directed by the Architect and as concrete work is completed, clear the site of gravel, concrete, appurtenances and debris. Leave the site in a clean, safe, well draining, neat condition.

END OF SECTION 321303

SECTION 323001 - POWDER COATED STEEL SAFETY AND HAND RAILINGS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. The extent of powder coated steel safety and hand railings is shown on the drawings.

B. Provide materials, labor, equipment, and services required to accomplish all related work in accordance with the drawings and specifications.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 321301 - Site Concrete Work

1.3 SUBMITTALS

A. Shop Drawings, Samples, and Manufacturer's Data: Provide five copies stamped and approved by the Contractor before submittal to the Architect. Submit to the Architect for review a minimum of two weeks before delivery to site.

1.3 REFERENCES

A. Publications:

1. American Galvanizers Association (AGA):

a. Inspection of Products Hot-dip Galvanized After Fabrications
b. The Design of Products to be Hot-dip Galvanized After Fabrication
c. Recommended Details of galvanized Structures
d. Quality Assurance Manual

2. Research Council on Structural Connections of the Engineering Foundation:

a. Specification for Structural Joints Using ATM A 325 or A 490 bolts.

3. Elsevier, van Eijnsbergen, J.F.H., New York, 1994:

a. Duplex Systems - Hot-Dip Galvanizing Plus Painting Wet Storage Stain

4. The Society for Protective Coatings (SSPC):

a. Surface Preparation Specification No. 1 Solvent Cleaning
b. Surface Preparation Specification No. 2 Hand Tool Cleaning
c. Surface Preparation Specification No. 3 Power Tool Cleaning
d. Surface Preparation Specification No. 7 Brush-Off Blast Cleaning

B. Reference Standards:

1. American Society for Testing and Materials (ASTM):

a. A 123/ A 123M Zinc (Hot-dip Galvanized) Coating of Iron and Steel Products
b. A 143 Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement
c. A 153/ A 153M Zinc Coating (Hot-Dip) on Iron and Steel Hardware
d. A 384 Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies
e. A 385 Practice for providing High-Quality Zinc Coating (Hot-Dip)
f. A 767/ A 767M Specification for Zinc Coating (Galvanized) Steel Bars for Concrete Reinforcement
g. A 780 Repair of Damaged Hot-Dip Galvanized Coatings
h. B 6 Specification for Zinc
i. D 6386 Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting
j. E 376 Practice for Measuring Coating Thickness by magnetic-Field or Eddy-Current (Electromagnetic) Test Methods

2. Federal Specifications:

a. DOD-P-21035 Painting, High Zinc Dust Content, Galvanizing Repair
b. MIL-P-26915 Primer Coating, Zinc Dust Pigmented

1.4 QUALITY ASSURANCE

A. Coating Applicator: Company specializing in hot-dip galvanizing after fabrication and following the procedures in the Quality Assurance Manual of the American Galvanizers Association.

B. Pre-construction Conference for Metal Fabricators: Contractor shall schedule a meeting to be attended by contractor, Architect, fabricator, and galvanizer. Topics to be addressed include project schedule, scope of metal fabrications, coordination between fabricator and galvanizer, finish of surfaces, application of coatings, submittals and approvals.

C. Coordination Between Fabricator and Galvanizer: Prior to fabrication, fabricator shall submit approved fabrication shop drawings to the galvanizer. The Galvanizer shall review fabricator shop drawing for suitability of materials for galvanizing and coatings and coordinate any required fabrication modifications.

D. Materials: For steel to be hot-dip galvanized, provide steel chemically suitable for metal coatings complying with the following requirements: carbon below 0.25%, phosphorous below 0.04%, manganese below 1.3% and silicon below 0.04%. Notify the galvanizer if steel does not meet these requirements so that suitability for galvanizing may be determined and whether special techniques are required.

1.5 SUBMITTALS:

A. Submit fabrication shop drawings for review by Architect of steel safety and hand railings.

B. Provide Manufacturer's Product Data (MPD), finish color paint sample and shop drawings. Shop drawings shall show the steel safety and hand railings in plan, elevation and section with details of connections, showing anchorage and accessory items.

C. Submit an original and two copies of the coating applicator's notarized Certificate of Compliance that the hot-dip galvanized coating meets or exceeds the specified requirements of ASTM A 123/ A 123M, A 153/ A 153M, or A767, as applicable.

1.6 JOB CONDITIONS

A. Job conditions in Section 311201 apply.

B. Construction Review: Notify the Architect when locations of steel safety and hand railing are staked out.

C. No work shall be fabricated until shop drawings for the work have been favorably reviewed by the Architect.

1.7 DELIVERY, STORAGE & HANDLING

A. Store and protect products under the provisions of Division 01.

B. Load and store galvanized articles in accordance with acceptable industry standards.

PART 2 - PRODUCTS

2.1 CONCRETE

Shall be as specified in Section 321301.

2.2 POWDER COATED STEEL SAFETY AND HAND RAILINGS

A. Posts and rails: 1-1/2" o.d. schedule 40 steel, meeting ASTM A-36. Shall be steel tubing, ASTM 500, grade A, fabricated in panels in reasonable lengths for transport and to reduce the quantity of field welding and field touch up painting. 1" x 1" baluster (pickets) shall be solid bar stock. Fabricate for standard sections not deviating from dimensions on details. Materials and methods of construction shall comply with the following standards:

American Institute of Steel Construction, (AISC)
American Welding Society, (AWS)
National Association of Architectural Metal Manufacturers, (NAAMM)

B. Steel Materials:

1. Material for galvanizing to be geometrically suitable for galvanizing as described in ASTM A 384 and A 385. Steel materials suitable for galvanizing include structural shapes, pipe and assemblies.

2. Material to be chemically suitable for galvanizing. Recommended steel materials for hot-dip galvanizing include but are not limited to:

a. Structural shapes and plates: ASTM A 36, A 242 Type 2, A 283, A 441, A 500, A 501, A 529, A 572, A 588 and A 992.
b. Steel for pipe or tubing: ASTM A 53, A 120 or A 595, Gr A or B.
c. Vertical pickets on safety railing shall be solid square steel bars free of rust.

C. Fabrication:

1. Fabricate structural steel in accordance with Class I, II, III guidelines as described in AGA's Recommended Details for Galvanized Structures.

2. Fabrication practices for products to be in a accordance with the application portions of ASTM a 143, A 384 and A 385, except as specified herein. Avoid fabrication techniques that could cause steel distortion or embrittlement.

3. The fabricator shall consult with Architect and hot-dip galvanizer regarding potential concerns, including handling issues, during the galvanizing process that may require design modification before fabrication proceeds.

4. Fabricate work in accordance with reviewed and accepted shop drawings and referenced standards.

5. Shop weld connections, except as otherwise indicated. Grind smooth welds and surfaces exposed to touch.

6. Provide joints and intersections tight fitting and securely fastened.

7. Provide metal fabrications work square, plumb, straight, and within allowable tolerances.

8. Drill or punch holes required for attachment of other work and bolted connections. Burned holes not acceptable.

9. Bend or form pipe and other members to continuous and true curves, with joints neatly fastened and assembled.

10. Provide for anchorage of type required, coordinated with supporting structure. Fabricate and space anchoring devices to provide adequate support for intended use.

11. Fabricate and preassemble items in shop to greatest extent possible to minimize field fitting and assembly.

12. Remove all welding slag, splatter, anti-splatter compound and burrs prior to delivery for galvanizing.

13. Provide holes and/or lifting lugs to allow for handling during galvanizing.

14. Avoid unsuitable marking paints. Consult with the galvanizer about removal of grease, oil, paint and other deleterious material prior to fabrication.

15. Remove by blast-cleaning, or other methods, surface contaminants and coatings that are not removable by the normal chemical cleaning process in the galvanizing operation.

D. Hot Dip Galvanizing: Provide a zinc coating for those items specified to be galvanized as follows:

1. ASTM A153, for galvanizing iron and steel hardware.

2. ASTM A123, for galvanizing rolled, pressed, and forged steel shapes, plates, bars, and strips 1/8" thick and heavier.

3. ASTM A386, for galvanizing assembled steel products.

E. Hot-Dip Galvanized Materials: Material for surface preparation to be suitable for powder coating is required to be Hot-Dip galvanized as described in ASTM A 123/A 123M and A 153/A 153M. Hot-Dip galvanized articles and fabrications may be newly galvanized, partially weathered or completely weathered.

F. Hot-Dip Galvanizing Requirements:

1. Hot-Dip galvanizing practices shall be in accordance with the applicable portions of ASTM A 123/A 123M and A 153/A 153M.

2. Water quenching or chromate conversion coating should be avoided as these processes interfere with paint adhesion and surface preparation.

3. Clean surface free of oil and grease. Prepare surface to promote adhesion by either applying chemical conversion coating or by brush blasting. If the blast clearing exposes bare steel, the bare steel shall be spot primed with an organic zinc rich coating.

G. Powder Coating

1. Shall be a thermosetting, super durable, TGIC polyester powder of a degassing grade.

2. The thickness of the polyester coating shall be a minimum of 3.5 mils when measured per ASTM D 1186. Using a 67 -1/2 volt wet sponge detector, the polyester coating shall be checked for holes, pinholes, and discontinuities. There shall be no more than one deficiency per 5 square feet.

3. The powder coating component of the duplex coating shall, at a minimum, meet the following requirements:

Direct impact	: ASTM D 2794	160 in/lb (9.0 m/kg)
Reverse impact	: ASTM D 2794	160 in/lb (9.0 m/kg)
Pencil hardness (scratch/gouge)	: ASTM D 3363	2H
Flexibility (Mandrel test)	: ASTM D 5221/8 in. (3m mm)	

Minimum adhesion crosshatch)	: ASTM D 3359	5A, 5B (100%
Salt spray	: ASTM B 117	+ 1000 hrs < 2mm
Gloss loss	: AAMA 2604-05	40% @ 5 yrs (S. Florida)
Color change	: ASTM D 2244	≥ ΔΣ 5.0 (Hunter Scale)

4. **Repair.** Material used for the touch up system shall be a two component aliphatic polyurethane, and color matched for patching the polyester coating used. The coating thickness of the touch up material shall be the same as the thickness of the polyester and can be applied in multiple coats.

5. **Color :** Shall be as approved by Architect and Owner.

PART 3 - EXECUTION

3.1 INSPECTION

Inspect substrates, field measure and verify installation conditions.

3.2 FABRICATION PREPARATION

A. Fabricate and assemble in shop where temperature, humidity, and dust conditions are controlled.

B. Set hardware that is shop installed.

3.3 SURFACE PREPARATION FOR HOT-DIP GALVANIZING

Pre-clean steel work in accordance with accepted methods to produce an acceptable surface for quality hot-dip galvanizing.

3.4 HOT-DIP GALVANIZED COATING APPLICATION

A. Galvanize steel members, fabrications and assemblies after fabrication by the hot-dip process in accordance with ASTM A123/123M.

B. Safeguard products against steel embrittlement in conformance with ASTM A 143.

C. Handle all articles to be galvanized in such a manner as to avoid any mechanical damage and to minimize distortion.

3.5 POWDER COATING REQUIREMENTS

A. Conform to paragraph 6.1 of ASTM A 123/A 123M, Table 1 of A 153/A 153M or Table 2 of A 767, as appropriate.

B. Surface finish: Continuous, adherent, as smooth and evenly distributed as possible and free from any defect detrimental to the stated end use of the coated article.

C. Adhesion: Withstand normal handling consistent with the nature and thickness of the coating and normal use of the article.

3.6 TESTS

A. Inspection and testing of hot-dip galvanized coating shall be done under the guidelines provided in the AGA publication Inspection of Products Hot-dip Galvanized after Fabrication.

B. Include visual examination and tests in accordance with ASTM A 123/A 123M and A 153/A 153M or A 767, as applicable, to determine the thickness of the zinc coating on the metal surface.

C. Furnish notarized Certificate of Compliance with ASTM standards and specifications herein listed. The Certificate must be signed by the galvanizer and contain a detailed description of the material processed. The Certificate shall include information as to the ASTM standard used for the coating.

3.7 INSTALLATION

A. Assemble and install steel safety and hand railing in accordance with final shop drawings and manufacturer's recommendations.

B. Perform fitting required for installation. Set work accurately in location, alignment, and elevation free of rack, measured from established lines and levels.

C. Fit exposed connections accurately together and field weld together to provide flush, tight hairline joints.

D. Adjust steel safety and hand railing sections before securing in place to ensure proper matching at butting joints and proper alignment throughout their length. Space posts as indicated, when not indicated at maximum five (5' o.c.) feet on center. Plumb posts in each direction. Refer to drawings and details for post installation in concrete footings.

E. Assembled steel safety and hand railing shall be firm, rigid, free of rattle and plumb. Connections shall provide maximum protection against tampering and vandalism.

F. Field touch paint chipped and scratched posts. Protect adjacent surfaces from paint spill and overspray. Clean spills and overspray.

G. Protect the steel safety and hand railing from damage until final acceptance.

3.8 REPAIR OF DAMAGED COATING

A. The maximum are to be repaired is defined in accordance with ASTM A 123/A 123M Section 6.2, current edition.

1. The maximum area to be repaired in the field shall be determined in advance by mutual agreement between parties.

B. Repair areas damaged by welding, flame cutting or during handling, transport or erection, by one of the approved methods in accordance with ASTM A 780 whenever damaged

exceeds 3/16" (4.8 mm) in width. Minimum thickness requirements for the repair are those described in ASTM A 123/A 123M Section 6.2 current edition.

3.9 CLEAN UP

During the contract and at intervals as directed by the Architect and as steel safety and hand railing installation is completed, clear the site of extraneous metal pieces, unused railing sections, concrete, gravel, asphalt or debris. Leave the site in a clean, safe, well draining, neat condition.

END OF SECTION 323001

SECTION 323002 - STEEL SWING GATES

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. The location of galvanized steel swing gate is shown on the drawings.

B. Provide materials, labor, equipment, and services required to accomplish all related work in accordance with the drawings and specifications.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 321301 - Site Concrete Work

B. Section 323003 – Metal Bollards

1.3 SUBMITTALS

A. Shop Drawings, Samples, and Manufacturer's Data: Shop drawings for gate including pre-engineered bracing, plate attachment, painted lettering and details illustrating height, width, size of posts, finishes, and installation procedures. Submit to the Architect for review a minimum of two weeks before delivery to site.

B. Manufacturer's Product Data (MPD):

1. Primer and paint
2. Galvanized steel paint

1.4 JOB CONDITIONS

A. Job conditions in Section 312201 apply.

B. Construction Review: Notify the Architect when steel swing gate is staked out.

C. Materials and methods of construction shall comply with the following standards:

American Institute of Steel Construction (AISC)
American Welding Society (AWS)
National Association of Architectural Metal Manufacturers (NAAM)

PART 2 - PRODUCTS

2.1 STEEL SWING GATES

A. Posts and rails: Schedule 40 galvanized steel, meeting ASTM A-36. Two coats rust inhibitive primer and two coats exterior grade enamel finish paint required. Standard of quality shall be Rustoleum or Architect approved equal. Color as directed by the Owner.

B. Appurtenances: Metal accessories shall be first quality, galvanized, and painted same as post and rails.

PART 3 - EXECUTION

3.1 FABRICATION

A. Take field measurements and coordinate work with others.

B. Shop fabricate in accordance with field measurements, favorably reviewed shop drawings and standards referenced above in Job Conditions.

C. Provide continuous weld shop connections, except as otherwise indicated. Grind smooth welds and surfaces exposed to touch.

D. Provide metal fabrications work square, plumb, straight and true to shop drawing dimensions.

E. Bend or form pipe to continuous and true curves, with joints neatly welded and assembled.

F. Galvanize fabricate swing gate as per galvanizing requirements.

G. Provide for anchorage of type required, coordinated with supporting structure. Fabricate and space anchoring devices to provide adequate support for intended use.

H. Fabricate, preassemble and paint assembly in shop to greatest extent possible to minimize field fitting and assembly.

3.2 FIELD INSTALLATION

A. Do not install gate until concrete for posts has attained its full design strength (approximately 28 days).

B. Transport safely and install as detailed.

C. Field touch paint chipped and scratched spots. Protect adjacent surfaces from paint spill and overspray. Clean spills and overspray.

3.3 CLEAN UP

A. During the contract and at intervals as directed by the Architect and as galvanized steel swing gate installation is completed, clear the site of all extraneous concrete, stone, asphalt or debris. Leave the site in a clean, safe, well draining, neat condition.

END OF SECTION 323002

SECTION 323003 - METAL BOLLARDS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. The extent of metal bollards is shown on the drawings and as specified in the contract documents.

B. Metal bollards work includes, but is not limited to, the following:

1. Providing and installing metal bollards and furnishings as noted in the specifications and as detailed.
2. Cleanup

C. Provide all labor, materials, tools, equipment, and services required to install metal bollards and furnishings as indicated on the plans and as specified.

D. The installation of all new materials shall be performed in strict accordance with the manufacturer’s installation instruction and in accordance with all approved shop drawings and submittals.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 321301 - Site Concrete Work

1.3 REFERENCES

A. Manufacturers Data and Recommended Installation Requirements

1.4 SUBMITTALS:

A. Provide Manufacturer's Product Data (MPD), Material Certificate and samples as noted:

1. Metal Bollard Cover (¼” nominal wall thickness polyethylene thermoplastic): MPD
2. Metal Bollard Cover (¼” nominal wall thickness polyethylene thermoplastic): Sample and Color Selection Chart
3. Reflective Tape: MPD and Sample

1.5 JOB CONDITIONS

A. Job conditions in Section 312201 apply.

B. Construction Review: Notify the Architect when footing location(s) for metal bollards are coordinated to avoid underground utilities and marked in the field.

1.6 QUALITY ASSURANCE

A. Manufacturer's warranties shall pass to the Owner and certification made that the product materials meet all applicable grade trademarks or conform to industry standards and inspection requirements.

B. Minimum (5) year warranty against fading.

1.7 DELIVERY, STORAGE, AND PROTECTION

A. Deliver products to project site in wrapped, neat, secure condition. Provide means to unload products from delivery trucks.

B. Protect all products and installation area from vandalism, theft, other construction, premature use, etc. until Owner acceptance and Architect sign off.

C. Materials delivered to the site shall be examined for damage or defects in shipping. Any defects shall be noted and reported to the Owners representative. Replacements, if necessary, shall be immediately reordered, so as to minimize any conflict with the construction schedule. Sound materials shall be stored above ground under protective cover or indoors so as to provide proper protection.

PART 2 - PRODUCTS

2.1 2.1 METAL BOLLARD

A. Pipe: Shall be galvanized schedule 40 steel pipe, 6 inch ID, 6.625" OD.

B. Concrete: Shall be 4,500 psi as specified in Section 321301.

2.2 REFLECTIVE TAPE: Shall be exterior grade, reflective. Standard of quality shall be Scotchgard, as manufactured by 3M or Architect approved equal. Color as noted on detail.

2.3 BOLLARD COVER: Shall be made of ¼" nominal wall thickness polyethylene thermoplastic (HDPE). Top shall be domed. Standard of quality shall be as manufactured by Ideal Shield or Architect approved equal. Color shall be selected by Owner, and approved by Architect.

PART 3 - EXECUTION

3.1 INSTALL METAL BOLLARD

A. Shop cut bollard.

B. Locate per plan and install as detailed. Neatly saw cut pavement or install bollards before paving.

C. Auger hole for concrete footing. Set metal bollard in center of hole and brace plumb and vertical.

D. Fill annular spaces around and inside metal bollard with concrete. Dome top of concrete footing and concrete inside metal bollard to shed water. Check for plumb alignment.

E. When concrete has set, remove braces.

F. Install bollard cover and reflective tape per manufacturer's recommendations.

G. Finished metal bollard shall be set plumb. Cover shall be smooth and free of chipped or cracked areas. Protect bollards until accepted.

3.2 CLEAN UP

During the contract and at intervals as required by the contract documents and as directed by the Architect and as metal bollards are installed, clear the site of all extraneous materials, rubbish, and debris. Leave the site in a clean, safe, well-draining, neat condition.

END OF SECTION 323003

SECTION 323004 - TRAFFIC SIGNS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. The extent of traffic signs is shown on the drawings.

B. Provide materials, labor, equipment, and services required to accomplish related work in accordance with the drawings and specifications.

1.2 SUBMITTALS:

A. Provide shop drawings for each different type and size of sign listed in the Traffic Sign Schedule.

B. Provide MPD for signposts, breakaway system, and sign plates.

1.3 JOB CONDITIONS

A. Job conditions in Section 312201 apply.

B. No work shall be fabricated until shop drawings for the work have been favorably reviewed by the Architect.

C. Construction Review: Notify the Architect when locations for signs are coordinated to avoid underground utilities and marked in the field for review.

D. Provide posts, bolts, splice bars, sign plates and build in coordination with work of other trades.

PART 2 - PRODUCTS

2.1 SIGNS

A. Sign Plate:

1. Sign Plate shall be aluminum sheets .090" (approximately 3/32") thick, with two coats of Dupont Imron spray semigloss paint.

2. Letters, numbers, symbols, and arrows shall be engineering grade, (EG) reflective. Sign plates, letters and numbers shall meet the colors and regulations described in the "Manual of Uniform Traffic Control Devices", latest edition, as published by the State of New York Department of Transportation, Division of Traffic and Safety.

3. The following Traffic Sign Schedule shall apply:

SIGN WORDING	SIGN NO.	SIZE	LETTER SIZE / COLORS
Stop	R1 - 1C	30" x 30"	10"C/White and Red
Do Not Enter	R3 - 15C	30" x 30"	4"/White and Red
No Parking Any Time	P1-1	12" x 18"	3"C/Red on White
Area Speed Limit 5 MPH	R2-3	18" x 24"	2"/White and Black

4. Refer to Traffic Sign Schedule and/or sign details on drawings for sign wording, quantities, and other information.

5. Hardware shall be galvanized.

6. Standard of quality shall be as manufactured by Eastern Metal/USA-Sign, www.usa-sign.com or Architect approved equal.

B. Breakaway Signposts:

1. Shall be minimum 2.5 lbs. / ft high carbon new billet steel (SP-80) U-channel posts with predrilled 3/8" holes at 1" on center.

2. Crashworthy to NCHRP 350 criteria. Meeting FHWA (Federal Highway Administration) for small sign support applications.

3. Lap Splice U-channel Breakaway System shall be 3/8” x ¾” x 5” and sized to post, bar color silver. Special manufacturer designed bolts for lap splice are required.

4. Hot dipped galvanized as directed by the Architect.

5. Standard of quality shall be “Rib-Bak” U-channel signposts as manufactured by NUCOR Steel Marion, Inc. www.nucorhighway.com (800) 333-4011 or Architect approved equal.

PART 3 - EXECUTION

3.1 INSTALL SIGNS

A. Erect signs plumb. Drive posts into firm ground or bolt to sleeve in pavement areas or concrete footings as detailed. Use driving caps to avoid deforming posts.

B. Mount sign plates at heights detailed. Attach metal sign plates to steel posts securely with 1/4" galvanized allen head screws.

3.2 CLEAN UP

During the contract and at intervals as directed by the Architect and as traffic sign installation(s) are completed, clear the site of extraneous paint, fasteners, concrete, gravel, asphalt, and debris. Leave the site in a clean, safe, well draining, neat condition.

END OF SECTION 323004

SECTION 329001 - PLANTING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. The extent of planting is shown on the drawings.

B. Planting work includes, but is not limited to, the following:

1. Soil preparation
2. Planting commercially grown trees.
3. Planting accessories
4. Maintenance: See watering, weed control and other specific requirements
5. Guarantee
6. Clean up

C. The Contractor shall provide materials, labor, equipment, and services required to accomplish related work in accordance with the drawings and specifications.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 311201 – Site Preparation

B. Section 312201 - Site Earthwork

C. Section 329201 – Sodded Lawns

1.3 SUBMITTALS

A. Furnish name of Landscape Contractor and/or Nurseryman to perform planting work and obtain Architect's approval.

B. Provide Material Certificates, MPD, Test Reports or Samples as noted for:

1. Mulch: Twelve (12 oz.) ounce sample
2. Planting Soil Mixture: Material Certificate and Test Report. See 1.4 F.
3. Plant Materials: Certificates of Inspection by regulatory agencies. Leave tags with botanical names and nursery source(s) on plants until reviewed by Architect.

1.4 QUALITY ASSURANCE

A. Perform planting in compliance with applicable requirements of governing authorities having jurisdiction.

B. Planting Contractor: Planting work by established Landscape Contractor and/or Nurseryman having sufficiently experienced crews, supervisor(s), specialized equipment and an excellent record of performance on completed planting projects of comparable size, scope, and quality. Provide expert plantsman to direct the work in the field on a regular, daily basis.

C. Nomenclature: Plant names shall conform to the latest edition of "Standardized Plant Names" as adopted by the American Joint Committee of Horticultural Nomenclature. Plants shall be true to botanical name, tagged with a waterproof, legible tag showing botanical name, size, and nursery source of origin.

D. Size and Grading: Plant sizes and grading shall conform to the latest edition of "American Standard for Nursery Stock" as sponsored by the American Association of Nurserymen, Incorporated (AAN), latest issue unless otherwise specified.

E. Nursery Source: Obtain freshly dug, healthy, vigorous, plants nursery grown under climatic conditions similar to those in the locality of the project for a minimum of two (2) years. Plants shall have been lined out in rows, annually cultivated, sprayed, pruned, and fertilized in accordance with good horticultural practice. Plants shall have been transplanted or root pruned at least once in the past three years. Balled and burlapped plants must come from soil which will hold a firm root ball. Heeled in plants and plants from cold storage not accepted.

F. Testing:

1. Engage an independent, qualified State of New York soil testing service. Pay for soil testing and inspection services.

2. Test representative material samples proposed for use as follows:

a. Planting Soil Mixture

(1) pH factor
(2) Mechanical analysis
(3) Percentage of organic content
(4) Recommendations on type and quantity of additives required to establish satisfactory pH factor and supply of nutrients to bring nutrients to satisfactory level for planting.

b. Peat Moss

(1) Loss of weight by ignition
(2) Moisture absorption capacity

1.5 JOB CONDITIONS

A. Job conditions in Section 312201 apply.

B. Planting seasons and timing conditions:

1. Unless otherwise directed in writing by the Architect, the planting of trees shall be from in the Spring, March 15 to June 1, and in the Fall, from October 15 to December 15. Refer to 1.5 Fall Planting Hazard restrictions below.

2. Proceed with and complete planting work as rapidly as portions of the site become available, working within the seasonal limitations for each kind of landscape work required.

3. Do not conduct planting operations until fine grading in the work areas has been completed satisfactorily.

4. Cooperate with other Contractors and trades working in and adjacent to planting locations. Examine drawings and specifications for the entire site and become familiar with the scope of other work required, especially underground utilities.

C. Construction Review:

1. Plants must be reviewed by the Architect before planting, either at the site or at the nursery.

2. Notify the Architect forty-eight (48) hours prior to delivery of plant materials to the site.

3. Plants not meeting specifications or not installed according to drawings may be rejected at any time by the Architect.

D. Provide plants of the species, size, and special characteristics noted on the Plant List. Substitutions not permitted unless approved in writing by the Architect. In the event that quantity discrepancies or material omissions occur in the Plant List, the planting drawings shall govern.

E. Contractor shall provide labor, water, hoses, sprinklers and watering equipment.

F. Fall Planting Hazard (FPH):

1. Notify the Architect in writing when any of the proposed plants are sensitive to fall planting in the experience of the Contractor. Plant materials noted as FPH in the PLANT LIST shall be planted in the Spring season. Assume sole responsibility of plant health related to materials noted FPH which are fall planted. Replace unhealthy or dead plants as described in the Guarantee.

2. Plants considered very risky to transplant in the fall include, but are not limited to, the following; (based on information obtained from Princeton Nurseries, Fall 2001- Spring 2002 catalog and experience of the Landscape Architect)

Acer rubrum & vars.	Platanus acerifolia
Betula varieties	Prunus - Stone fruits
Carpinus varieties	Pyrus - Pears
Cornus florida & vars.	Quercus - Oaks
Crataegus varieties	Salix - weeping vars.
Halesia	Strax japonica
Koelreuteria	Tilia tomentosa
Liquidambar styraciflua	Zelkova varieties
Liriodendron tulipifera	Pinus nigra

3. Evergreen plant materials are also considered a fall planting hazard.

PART 2 - PRODUCTS

2.1 PLANTS

A. Plants shall be well formed without voids and open spaces, typical of their species or variety, with normal habit of growth. Plants shall be first quality, sound, healthy, vigorous, well branched and densely foliated. Plants shall have healthy, well developed fibrous root systems. They shall be free of defects, disfiguring knots, sun-scald injuries, frost cracks, abrasions, disease, insect pests, eggs, and larvae.

B. Plants shall conform to the measurements specified in the Plant List. Measurements specified shall be minimum size acceptable for each variety. For each plant of minimum size, provide a plant of maximum size. Plants that meet the requirements specified in the Plant List, but do not possess a normal balance between height and spread will not be accepted. Plants for use when symmetry is required, or in rows, shall be matched as nearly as possible. Plants shall not be pruned prior to delivery.

C. Plants and tree trunks shall be measured when the branches are in their normal position. Dimensions for height and spread as contained herein refer to the main body of the plant and not from branch-tip to branch-tip. Shade trees shall be free of branches up to seven feet, with a single leader, well branched and reasonably straight stems. No trees which have had their leaders cut or damaged will be accepted. Trees must have straight trunks with single leader intact. There shall be no abrasion of the bark and no fresh cuts of limbs over one (1") inch which has not been completely calloused over.

D. Balled and burlapped plants with firm, natural balls of earth of sufficient diameter and depth to encompass the fibrous and feeding root system necessary for full recovery of the plant. Provide ball sizes complying with the latest edition of the "American Standard for Nursery Stock." Cracked or mushroomed balls are not acceptable.

2.2 PLANTING ACCESSORIES

A. Planting soil mixture for trees shall be premixed in bulk, and contain the following by volume:

20 parts clean on site soil
10 parts topsoil

B. Topsoil: 5-10% organic, 20-50% passing 200 mesh sieve. Fertile, friable, natural topsoil of leafy character, without admixture of subsoil material, obtained from a well-drained arable site, reasonably free from clay, lumps, coarse sand, stones, plants, roots, sticks, and other foreign materials, with acidity range of between pH 6.5 and 7.5, free of substances harmful to plants which will be grown in the soil.

C. Starter Fertilizer: Water soluble fertilizer and plant food 10-52-17 containing no sulfate or chloride salts. Standard of quality shall be as manufactured by Fairlawn Chemical Co., Inc., 485 Holt Road, Webster, NY (585) 671-2400, and distributed by Organix, 569 Klem Road, Webster, NY (585) 787-2711 or Architect approved equal.

D. Peat Moss: Brown to black in color, weed and seed free, dried sphagnum peat moss, containing not more than 9% mineral on a dry basis and conforming to NYSDOT 713-20.

E. Stakes: Minimum eight (8') foot long, two (2") inch round or square sound wood stakes.

F. Hose: New, two (2) ply garden hose not less than one-half (1/2") inch in diameter.

G. Guy Wire: 10 gauge galvanized steel wire for guying plantings where specified.

H. Tree Wrap: Standard of quality shall be four (4") inch wide waterproof 30-30-30 Krinklecraft, or Architect approved equal.

I. Mulch:

Ground or shredded bark, medium size, from softwood trees. No pieces over two (2") inches in greatest dimension. Free from sawdust, stones, debris, and deleterious materials.

J. Anti-desiccant: Standard of quality shall be "Wiltpruf" or Architect approved equal.

PART 3 - EXECUTION

3.1 LAYOUT: Locate and stake in the field individual trees for approval by the Architect prior to commencing planting operations.

3.2 GENERAL PLANTING OPERATIONS

A. Transportation and Handling: Take precautions customary in good trade practice in preparing plants for moving. Workmanship that fails to meet the highest standards will be rejected. Spray deciduous plant's foliage with an approved "Anti-Desiccant" immediately after digging to prevent dehydration. Dig, pack, transport, and handle plants with care to ensure protection against injury. Do not hold or move trees by stems. Support and protect root balls.

B. Inspection certificates required by law shall accompany each shipment invoice or order to stock and on arrival, the certificate shall be filed with the Architect.

C. Protect plants from drying out. When plants cannot be planted immediately upon delivery, properly protect them with soil, wet peat moss, or in a manner acceptable to the Architect. Water heeled-in plantings daily. No plant shall be bound with rope or wire in a manner that could damage or break the branches. Cover plants transported on open vehicles with protective covering to prevent wind burn. Do not hold or move trees by stems. Support and protect root balls.

D. Provide dry, loose prepared planting soil for planting bed mixes. Frozen or muddy soil is not acceptable.

E. Excavate tree pits as dimensioned and located on drawings. When soils harmful to plant materials are encountered, immediately notify the Architect.

F. Plants shall be set plumb and straight and at such a level that after settlement, a normal or natural relationship of the crown of the plant with the ground surface will be established. Each plant shall be planted in the center of the pit. When balled, burlapped, and platformed plants are set, the platform shall first be removed from the pit and topsoil shall be carefully tamped under and around the base of each ball to fill voids. Burlap, ropes, and wires shall be removed from the sides and tops of balls, but no burlap shall be pulled out from under the balls.

G. Plants shall be planted in the planting soil mixture which shall be thoroughly watered and tamped. On level ground or slight slopes, a shallow basin a little larger than the diameter of the plant pit shall be left around each plant as shown on the drawings or as directed by the Architect. On steep slopes, the soil on the lower side of the plant shall be graded in such a manner that it will catch and hold water as shown on the drawings or as directed by the Architect.

H. Staking: Trees two (2") inch caliper or less shall be staked with two stakes. The trunks of trees larger than two (2") inches shall be staked with three stakes, equally spaced about the tree, set vertically and securely fastened. The trees shall be guyed with two or three strands of wire as specified, which shall run through the rubber hose and be securely tightened.

I. Mulching: Spread continuous four (4") inches settled depth of mulch over finished surface of each plant as detailed. Water plants thoroughly after mulching. NOTE: The Architect may field check depth of mulch for proper weed control barrier since no weed control fabric is required.

J. Wrap deciduous trees with tree wrap to first branch and secure wrap.

K. Pruning: Each tree shall be pruned to preserve the natural character of the plant. Remove dead wood and crossing branches. Do not prune terminal leaders. Refer to drawings for additional tree pruning details.

L. Anti-Desiccant: Immediately after planting and staking, trees shall be sprayed with anti-desiccant, using an approved power sprayer to apply an adequate film over trunks, branches, twigs, and/or foliage. Apply according to manufacturer's recommendations.

M. Replacements: Remove and immediately replace plants, as determined by the Architect, to be unsatisfactory during the initial planting installation.

3.3 MAINTENANCE

A. Maintenance by Contractor begins as soon as plants are installed. Protect plants from drought, washout and wind erosion. In general, maintain new plantings, including watering, weeding, pruning, applications of herbicides, fungicides, insecticides and pesticides, until healthy, vigorous plants are accepted by the Architect. Specifically:

1. Protect: Protect plantings against harsh weather, trespass and vandalism by wrapping, staking, temporary fencing or other means.

2. Water: The Contractor shall provide water, labor, hoses, sprinklers and watering equipment to maintain plants, prevent them from drying (browning) out, and keep plants in a healthy, growing condition until final acceptance.

3. Cultivate: Cultivate plants by straightening any settled plant materials, restaking and guying, rewrapping, pruning dead and broken branches, weeding and re-applying anti-desiccant, herbicide, fungicide, insecticide and pesticide.

4. Should the Contractor fail to protect and maintain the plantings, the Owner may issue a three (3) day notification to the Contractor, hire work done, and backcharge this Contractor.

B. Maintenance by the Contractor continues until Certificate of Final Acceptance, or Final Punch List is satisfactorily completed and accepted by the Architect, whichever is later. Maintenance by Owner begins as soon as the Architect issues Certificate of Final Acceptance or Final Punch List is satisfactorily completed and accepted by the Architect, whichever is later.

3.4 STANDARDS FOR ACCEPTANCE: Review to determine acceptance of plantings will be made by the Architect upon request. Provide notification at least five (5) working days before requested review date.

A. New plantings will be acceptable provided requirements, including maintenance, have been complied with. Healthy, well-formed, vigorous plants, true to species and size on Plant List, must be established, free of disease, broken branches and insects.

B. Any plant which is poorly formed, structurally unsound, not true to species and size on Plant List, diseased, contains broken branches, or is generally unhealthy (containing 25% or more browned out foliage), shall be rejected and replanted at no additional cost to the Owner.

3.5 GUARANTEE

A. Contractor shall guarantee plant materials to be true to species and size on Plant List, and in vigorous growing condition, for a period of one (1 yr.) year from the date given on the Certificate of Substantial Completion or Final Punch List is satisfactorily completed and accepted by the Architect, whichever is later.

B. Any plant material that does not meet the Standards for Acceptance shall be replaced as soon as weather conditions permit. Replacement plantings shall be made in accordance with the specifications and drawings. Replacements shall be subject to inspection, acceptance, and guaranteed for one (1 yr.) year after date of replanting and acceptance by the Architect.

3.6 CLEAN UP

During the contract and at intervals as directed by the Architect and as planting is completed, clear the site of extraneous materials, pots, flats, hose, wire, stakes, pruned branches, rubbish, and debris. Leave the site in a clean, safe, neat, well draining condition.

END OF SECTION 329001

SECTION 329201 - SODDED LAWNS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. The extent of the lawn work is shown on the drawings. The lawn work limits equal the Contract Limit Line except as noted on the drawings. Non-paved, non-roofed areas within the Contract Limit Line shall receive four (4") inches settled depth of topsoil and lawn sod. Existing lawn areas that are not disturbed require no additional work. Lawn types as shown on the drawings are defined as follows:

1. Lawn: Strip and stockpile 4" topsoil, mechanically screen, blend with compost, replace 4" topsoil, and sod.

B. Lawn work includes, but is not limited to, the following:

1. Placing and spreading stockpiled topsoil
2. Importing, placing and spreading topsoil
3. Sod bed preparation and placing
4. Sodding lawns
5. Mulching and fertilizing
6. Maintenance: See watering, mowing, fertilizing, core aerating, weed control, grow in and other specific requirements.
7. Clean Up

C. Provide materials, labor, equipment, and services required to accomplish related work in accordance with the drawings and specifications.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 311201 - Site Preparation (Topsoil Stripping)

B. Section 312201 - Site Earthwork

C. Section 329001 - Planting

1.3 REFERENCES

A. ASTM D4972 - Standard Test Method for pH of Soils

B. ASTM D5268 - Standard Specification for Topsoil Used for Landscaping Purposes

C. ASTM D422 and D1140 - Standard Test Method for Particle Size Analysis of Soils

D. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effect

E. ASTM F1647 - Standard Test Method for Organic Material Content of Athletic Field Rootzone Mixes.

F. ASTM F1632 - Standard Test Method for Particle Size Analysis and Sand Shape Grading of Golf Course Putting Green and Sportsfield Rootzone Mixes

G. ASTM F2060 - Standard Guide for Maintaining Cool Season Turfgrasses on Athletic Fields

H. National Turfgrass Federation, Inc.

I. National Turfgrass Evaluation Program (NTEP).

J. Cornell Universities: Sportsfield Management Guidelines

K. Turfgrass Producers International: Guideline Specifications to Turfgrass Sodding, latest edition.

1.4 SUBMITTALS: (See Section 311201, 1.5)

A. Furnish name of Landscape Contractor or Nurseryman to perform lawn work and a list of completed projects including contact information for each project demonstrating compliance with applicable qualification requirements outlined in 1.5 "Quality Assurance" of this specification section.

B. Provide Material Certificates and MPD for:

1. Sod species and source, location for sod producer
2. Limestone
3. Fertilizers

C. Provide Topsoil Test Report (for Onsite and Imported Topsoil): Submit test results from Architect approved independent testing laboratory on their letterhead. Report shall:

1. Certify soil texture, organic content, and particle size analysis.
2. Chemical analysis testing nitrogen, phosphorus, potassium, calcium, magnesium, cation exchange capacity, base saturation percentages, micronutrients and acidity (pH).
3. Provide timing and rates of soil additives, liming and fertilizers. (Materials and procedures regarding soil amendments and fertilizers specified in this section are approximate.) Adjust all soil amendments to comply with test results based on actual soil tests and as directed by the Architect at no additional cost to the Owner.

D. Provide letter on Contractor’s letterhead certifying that only topsoil from the above tested source was used on the project.

E. Provide schedule for review and approval as outlined under "Sequence and Scheduling" of this specification section.

1.5 QUALITY ASSURANCE

A. General Lawn Contractor: Work shall be contracted to a single, established Landscape Contracting or Nursery firm having sufficiently experienced crews, supervisor(s),

specialized equipment, and an excellent record of performance on completed lawn projects of comparable size, scope, and quality. Provide expert turfman to direct the work in the field on a regular, daily basis. The expert turfman shall be employed by the same company engaged in the installation of the lawn work for a minimum of five (5) years.

B. Sod Standards: Comply with the Turfgrass Producers International: Guideline Specifications to Turfgrass Sodding, latest edition.

C. Nomenclature: Names shall conform to the National Turfgrass Federation, Inc.

D. Testing: If required by the Architect for poor lawn grow in, engage an Architect approved independent, qualified New York State testing service and turfgrass specialist to evaluate Contractor grow in practices and materials used. Pay for all testing/inspection services, materials, and manpower to correct lawn areas as approved by the Architect.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Sod:

1. Cut, deliver, and install sod within a 24-hour period. Sod cutting and shipping shall be coordinated with the sod installers.

2. Do not harvest or transport sod when moisture content may adversely affect sod survival.

3. Protect sod from sun, wind, and dehydration prior to installation.

4. Do not tear, stretch or drop sod during handling and installation.

5. Store sod materials at site in an orderly manner at location(s) acceptable to the Architect.

B. Fertilizer:

1. Deliver fertilizer in the manufacturer's standard sized bags showing the weight, analysis, and manufacturer's name. Store all fertilizer under a waterproof cover or in a dry place as approved by the Architect.

1.7 JOB CONDITIONS

A. Job conditions in Section 312201 apply.

B. Lawn Work:

1. Perform lawn work after planting, fine grading and other work affecting the ground surfaces in the lawn work areas has been completed satisfactorily.

2. Where practical, the Owner will provide a connection to the water system such as, but not limited to, existing yard hydrants, building hose bibs, etc. If this source is insufficient, not available or practical to provide a source of sufficient

water to meet the requirements herein, the Contractor shall secure a water source sufficient to meet the water requirements herein such as, but not limited to, municipal hydrants, water truck, etc. at no additional cost to the Owner.

3. Contractor shall provide all watering equipment and appurtenances such as, but not limited to, meters, backflow preventer, labor, hoses, sprinklers, irrigation and watering equipment.

4. Calendar dates for sodding under "Sequence and Scheduling" of this specification section shall apply.

5. Place sod only when ground surface is free of mud, frost, snow and ice.

6. Protect newly sodded lawns from vehicles, vandalism, or trespass. Provide temporary fencing or barriers as required.

C. Construction Review:

1. Upon completion of topsoil spreading and sod bed preparation, notify Architect to review work.

2. The Architect may review fine graded areas by the Contractor to check for surface smoothness and general compliance with grading requirements. Fill or cut by hand raking or other acceptable means to achieve smooth, even well-draining lawn surfaces free of "bird baths" and breaks in grade as directed by the Architect at no additional expense to the Owner.

3. Review of any fine graded lawn areas by Architect shall not alleviate the Contractor of his responsibility for conforming to the required grades as shown on the drawings, nor be misconstrued as final acceptance of lawn work.

1.8 SEQUENCING AND SCHEDULING

A. Schedule: Prior to construction, provide a schedule which addresses the following lawn thresholds involving erosion control stabilization:

1. Sodding Installation: The Contractor may invoice for 50% of the approved schedule of value breakdown at the time of acceptable installation.

a. Unless otherwise directed in writing by the Architect, sod lawns from April 1 to May 15, and from August 15 to October 1. Sodding between May 16 and August 14 is not acceptable unless adequate water supply is available and applied to the turfgrass as required herein and approved by the Architect.

b. Proceed with and complete sodding as rapidly as portions of the site become available, working within the seasonal limitations for each kind of landscape work required.

2. Substantial Completion: The Contractor may invoice for 25% of the approved schedule of value breakdown at the time of substantial completion as described in

Part 3, "Standards For Substantial Completion Of Lawns" of this specification section. At this time, the Architect may issue the Notice of Termination to satisfy the NYS DEC stabilization requirements. The date of substantial completion is anticipated approximately 60 days after lawn installation presuming all Contractor maintenance operations have been vigorously performed.

3. Final Acceptance: The Contractor may invoice for the final 25% of the approved schedule of value breakdown at the time of final acceptance as described in Part 3, "Standards For Final Acceptance Of Lawns" of this specification section. The date of final acceptance is anticipated approximately 30 days after substantial completion presuming all Contractor maintenance operations have been vigorously performed.

4. Owner Maintenance: After final acceptance of the lawns, the Owner will maintain for 1 to 3 growing seasons to reach competitive maturity and beyond per ASTM F2060.

PART 2 - PRODUCTS

2.1 TOPSOIL

A. Source: Provide from off site, Architect approved source, when stripped, stockpiled and amended quantity is inadequate to provide four (4") inches settled depth of topsoil for all lawn areas at no additional cost to the Owner.

B. Texture and Content: Provide topsoil conforming to the following:

1. Soil texture and content:

a. Sandy loam topsoil, well drained homogeneous texture and of uniform grade, without the admixture of subsoil material. Topsoil shall be entirely free of dense material, hardpan, clay, stones over 3/4" in diameter, sod, or any other objectionable foreign material, including but not limited to, glass, debris, toxins, hazardous wastes and chemicals (such as atrizene or muriatic acid within the past seven (7) years) that may be injurious to humans, animals and plant materials.

b. Organic Matter: Containing not less than 5% or more than 10% organic matter in that portion of a sample passing a 1/4" sieve when determined by the wet combustion method on a sample dried at 105 degrees F.

2. pH Value: Containing a pH value within the range of 6.0 to 7.0 on that portion of the sample which passes a 1/4" sieve.

3. Soluble salt content: Not higher than 500 parts per million.

4. Sieve Analysis for general lawn work: Shall be screened or rock picked to meet the following gradation:

Sieve Designation	% Passing

3/4"	100
1/4"	97-100
No. 200	20-65 (of the 1/4" sieve)

C. No lawn shall be sodded on topsoil that has been chemically treated until sufficient time has elapsed to permit dissipation of all toxic materials. The Contractor shall assume full responsibility for any loss or damage to turfgrass sod, as indicated herein, arising from improper use of chemicals or due to failure to allow sufficient time to permit dissipation of toxic residues, whether or not such materials are specified herein.

2.2 SOD

A. Sod shall conform to NYSDOT Item 713-14 and be approved nursery grown mineral soil sod with 60% Kentucky Bluegrass and 40% Fine Fescue blend with a minimum (4) varieties. Muck grown sod is NOT acceptable. Installation of plastic netting is NOT acceptable.

B. Provide well-rooted, healthy sod, free of diseases, nematodes and soil borne insects. Provide sod uniform in color, leaf texture, density, and free of weeds, undesirable grasses, stones, roots, thatch and extraneous material viable and capable of growth and development when planted. Sod is considered free of weeds when less than five (5) weeds are found per one hundred (100 s.f.) square feet.

C. Thickness of Cut: Furnish sod machine cut at a uniform soil thickness of 0.60 inch at the time of cutting and of supplier's standard width, length, and thickness: uniformly 1" to 1-1/2" thick with clean cut edges. Measurement of thickness shall exclude top growth and thatch. Mow sod before stripping.

D. Mowing Height: Before stripping, sod shall be mowed uniformly at a height of 1 to 1-1/2 inches.

E. Thatch: Sod shall be relatively free of thatch, up to 1/2 inch allowable (un-compressed).

F. Pad Size:

1. For General Lawn: Individual pieces of sod shall be cut to the supplier's standard width and length. Maximum allowable deviation from standard widths and lengths shall be plus or minus 1/2 inch on width and plus or minus 5% on length. Broken pads and torn or uneven ends will not be acceptable.

2. For Large Areas: Sod shall be thick-cut "big" rolls of 250 s.f. Maximum allowable deviation from standard width and lengths shall be plus or minus 1/8" on width and plus or minus 1/2% on length. Broken and torn or uneven rolls will not be acceptable.

G. Strength of Sod Sections: Standard size sections of sod shall be strong enough to support their own weight and retain their size and shape when suspended vertically from a firm grasp on the upper 10% of the section.

H. Standard of Quality: Shall be Premium Sod supplied by Batavia Turf (585) 548-2552, Sky High Turf Farms (315) 687-6510, Saratoga Sod Farm (518) 664-5038, Lakeside Sod (716) 741-2877 or Architect approved equal.

2.3 LIMESTONE

A. Shall be ground limestone in the producer's standard bags containing not less than 85% total carbonates and conforming to the following gradations:

Sieve Designation	% Passing
No. 100	50-100
No. 20	100

B. The lime shall be uniform in composition, dry and free flowing and shall be delivered to the site in the original, unopened containers, each bearing the manufacturer's guaranteed analysis. Any lime which becomes caked or otherwise damaged making it unsuitable for use will be rejected.

2.4 FERTILIZER

A. For Starter Fertilization: Immediately prior to sodding, fertilize with a commercial starter fertilizer, granular, non-burning product, with not less than 90% organic slow acting, micro nutrients and 1% iron, guaranteed analysis commercial fertilizer. Fertilizer ratio shall be: (1-2-1). Apply at a rate of 0.33 - 0.66 lbs of nitrogen (N) per 1,000 sf.

B. For Subsequent and Final Fertilizations: Apply commercial fertilizer, poly coated granular non-burning product with not less than 90% organic slow acting, guaranteed analysis

1. For Spring and Fall Lawn Work: Fertilizer ratio shall be: (3-0-1). Apply at rate of 1.5 - 2 lbs nitrogen (N)/1,000 s.f.

2.5 WATER: Free of substance harmful to lawn, other plants, humans and animals.

2.6 COMPOST

A. Compost shall contain organic matter or material of a generally humus nature capable of sustaining vegetation growth, with no foreign matter (ie. glass, plastic, etc.) or other material toxic to plant growth. It shall be free from stones, lumps, or similar objects larger than one-half inch in greatest diameter, roots, and brush. Composts derived from organic wastes such as food and agricultural residues and animals manures, and sewage sludge that meet the above requirements, and are approved by the National Environmental Protection Agency and NYS Department of Environmental Conservation are acceptable compost sources.

B. Compost shall have the following properties:

Parameters	Range
pH	6.0 to 7.5
Moisture Content	35 to 55%

Particle Size	< 1/2"
C:N Ratio	15:1 to 30:1
Soluble Silts	< 4.0 minutes (ds)
Organic Matter Content	> 20%
Bulk Density	< 1200 lbs/cy
Foreign Matter	< 1% (dry weight)

C. Standard of quality shall be WeCare Organics, P.O. Box 785, Hillburn, NY 10931, (845) 753-2242, www.wecareorganics.com, or Architect approved equal.

PART 3 - EXECUTION

3.1 INSPECTION

A. Verify limits of lawn and other types of ground cover materials in the field with drawings. Also any imported and screened topsoil areas. Notify Architect of discrepancies prior to proceeding with lawn work.

B. Examine finish surfaces, grade, topsoil quality, and depth.

C. Do not start lawn work until unsatisfactory conditions are corrected to the satisfaction of the Architect.

3.2 SPREAD TOPSOIL

A. Limit preparation to areas which will be immediately sodded.

B. Perform topsoil spreading operations only during dry weather.

C. To insure a proper bond with the topsoil, disc, harrow, or otherwise scarify and loosen the lawn subgrade to a depth of four (4") inches before spreading topsoil.

D. Spread topsoil to ensure a minimum settled depth of four (4") inches in lawn areas.

3.3 PREPARE GENERAL LAWN AREAS TYPE 1

A. Perform a pH test, sieve, and nutrient analysis of the topsoil and advise the results to the Architect prior to adding limestone or other soil amendments. Soil amendments shall be uniformly incorporated into the top four (4") inches of topsoil by discing, harrowing or other approved methods.

B. Remove debris and stones 3/4" or larger by handpicking, fine tooth aluminum grading rakes, and mechanized stone picker. When topsoil has hardened, cultivate soil to a four (4") inch depth by plowing, discing, harrowing, or otherwise scarifying and loosening the topsoil.

C. Grade lawn areas to a smooth, free draining even surface with a loose, moderately coarse texture. Scarify, rake, level, and roll with a light static roller as necessary to obtain true, even lawn surfaces and fill depressions as required to drain. Correct irregularities in the surface resulting from tillage operations to prevent formation of depressions or water pockets.

D. Cultivate soil to provide a firm bed of minimum of four (4") inches deep, free of clods, stones, or foreign matter over 3/4" in diameter from the top of soil. Do not move heavy objects except necessary lawn making equipment over the lawn areas after the soil is prepared unless it is again loosened and graded. Remove stones and all debris greater than one 3/4" in diameter during cultivation. Level undulations and irregularities in the surface.

E. For pH correction provide adjusted rate of application as recommended in Topsoil Test Report submittal. For low pH correction: Add ground limestone at the rate indicated by the soil test. For high pH correction: Materials and application rates shall be determined by appropriate soil tests.

F. Place starter fertilizer at the rate of 0.33 - 0.66 lbs. of nitrogen (N) per 1,000 sf. and mix into full depth of topsoil.

G. Rake area with fine toothed aluminum grading rake before placing sod to obtain a smooth surface at the proper elevation. Drag area with a wood float to level out minor humps and hollows. Beds shall have a smooth friable uniform surface, free of areas ponding water.

3.4 SODDING

A. Notify Architect that sod bed is ready for review as specified in Job Conditions. Obtain Architect's approval prior to sodding.

B. Moistening the Soil: During periods of higher than optimal temperature for species being specified and after unevenness in the soil surface has been corrected, the soil shall be lightly moistened immediately prior to laying the sod.

C. Sod immediately after preparation of bed and Architect's approval.

D. Lay sod to form a solid mass with tightly-fitted joints in strips parallel to contours. Butt ends and sides of sod strips. Do not overlap edges. Stagger strips to offset joints in adjacent courses. Remove excess sod to avoid smothering of adjacent grass. Provide sod pad top flush with finish grade of adjacent curbs, pavements, drainage structures and lawn areas.

E. Do not lay dormant sod or install sod on soil surfaces that are hot, dry, saturated or frozen.

F. When sodding slopes, install initial row of sod in a straight line, beginning at bottom of slope. Place subsequent rows parallel to and lightly against previously installed row.

G. Sod strips laid in drainageways must meet the finished grades shown on the drawings.

H. Sod abutting existing lawn shall meet flush with top of sod pad (soil and thatch). Remove excess topsoil as necessary to meet flush.

I. Stake sod in lawn swales and on lawn slopes 3H to 1V (horizontal to vertical) and steeper to prevent slippage. Use two (2) biodegradable stakes per square yard of sod. Stakes are to have their flat sides against the slope and be driven flush with sod surface.

J. Roll with light static lawn roller to ensure contact with subgrade.

K. As sodding is completed in anyone section, water sod thoroughly to a depth sufficient to ensure the underside of the new sod pad and topsoil immediately below the pad is thoroughly wet. Contractor is responsible to ensure there is an adequate water supply available prior to installation. Do not allow sod to dry out.

3.5 MAINTENANCE

A. Maintenance by Contractor begins as soon as lawns are sodded. Protect lawns from drought, washout and wind erosion. In general, maintain new installed lawn areas, including watering, fertilizing, core aerating, spot weeding, mowing, applications of herbicides, fungicides, insecticides, and re-sodding until a full, uniform, healthy, vigorous stand of grass free of weed, undesirable grass species, disease, and insects is achieved and accepted by the Architect. Specifically:

1. Watering Sodded Lawns:

a. First Week: Soil on sod pads shall be kept moist. In the absence of adequate rainfall, watering shall be performed daily or as often as necessary during the first week and in sufficient quantities to maintain moist soil to a depth of at least four (4") inches.

2. Second and Subsequent Weeks: Contractor shall provide water to the lawns as required to maintain adequate moisture, in the upper four (4") inches of soil, necessary for the promotion of deep root growth until final acceptance. After 2nd mowing, water two (2) times weekly until thoroughly established.

3. Protect: Protect lawn areas against trespass, vandalism and routine pedestrian traffic and Owner maintenance traffic by temporary fencing or other means.

4. Repair: Repair, rework, and resod areas that have washed out, eroded, do not germinate and are vandalized or otherwise damaged.

5. Mow: Initial mowing shall begin when the blade height reaches 2" and the soil will bear the weight of the lawn mower. Use mowers with low impact tires. For the first 3 mowings cut the grass blades to 1.5 inches. After that mow the grass when it reaches a height of about 3.5" to a height of about 2.5". Never remove more than 1/3 of the grass blade at any one mowing. A minimum of eight (8) to ten (10) mowings are required (approximately once per week after the initial germination period to final acceptance). Notify the Architect of dates in writing as mowing is performed. Excess clippings shall be carefully raked so as not to remove healthy grasses, and removed.

6. Core Aerating: Between mowings three (3) and four (4), and between mowings seven (7) and eight (8) core aerate lawns about three (3") inches on center minimum three (3") inches deep to ensure aggressive root growth. This will

require multiple passes at different directions to achieve 16 to 20 holes 3/4" to 1" diameter per square foot. Sweep scattered plugs off paved areas onto adjacent lawn areas. Pulverize plugs during subsequent mowing operations. Provide additional core aerating after the 10th mowing as directed by the Architect to expedite the lawn maturation process. Moisten field by thoroughly watering the topsoil profile, several days in advance of coring to facilitate proper penetration of the topsoil.

7. Fertilizer: Immediately after core aerating, between mowings three (3) and four(4), and between mowing seven (7) and eight (8) apply subsequent fertilizer at the rate of 1.5-2 lbs./1,000 s.f. Provide additional fertilizer after the 10th mowing as directed by the Architect to expedite the lawn maturation process. Apply a final fertilizer just prior to final acceptance at the same application rate.

8. Weed Control: When infestation of weeds or crabgrass develops, treat infestation by hand weeding or herbicides control appropriate to the area. Furnish and install weed chemical control as recommended by manufacturer. Herbicides controls must be acceptable to the Owner. Obtain and pay for permits. Use as directed by the manufacturer and applicable laws, codes, ordinances and regulatory requirements. Under NO circumstances is it acceptable to overseed over Nutsedge, Crabgrass or other grassy/broadleaf weeds.

B. Maintenance by the Contractor continues through the certificate of substantial completion to final acceptance by the Architect as described below. Maintenance by Owner begins after final acceptance of the lawn.

3.6 STANDARDS FOR SUBSTANTIAL COMPLETION OF LAWNS: Review to determine substantial completion of lawns will be made by the Architect, upon request. Provide notification at least five (5) working days before requested review date.

A. Lawn areas will be substantially complete provided requirements, including maintenance, have been complied with. A healthy, vigorous, uniform, partially mature stand of lawn is established free of weeds, undesirable grass species, disease, and insects. With proper watering and maintenance as indicated herein, this should culminate after an approximate 60-72 day period for initial germination with average temperatures above 40°F. Grass roots shall have matured to a minimum of 1½" depth as determined by the Architect when core samples are taken.

B. Lawn areas shall not have more than 10% dead/bare spots.

C. Contractor shall provide a written copy of all maintenance activities performed up to this date.

D. The architect will prepare a written punch list of items which need correction prior to final acceptance.

3.7 STANDARDS FOR FINAL ACCEPTANCE OF LAWNS: Review to determine final acceptance of lawns will be made by the Architect, upon request. Provide notification at least five (5) working days before requested review date.

A. Lawn areas will be acceptable provided requirements, including maintenance, have been complied with. A healthy, vigorous, uniform, full stand of lawn is established free of weeds, undesirable grass species, disease, and insects. Grass roots shall have matured to a minimum of 2" depth as determined by the Architect when core samples are taken.

B. Any lawn which contains disease, more than 1% dead/bare spots, or any dead/bare area greater than one (1) square foot shall be rejected and the unacceptable area(s) repaired as originally specified at no additional cost to the Owner.

C. In the event the Contractor fails to complete the punch list items within a 30 day period with average temperatures of 40°F after the time of Substantial Completion, the Contractor shall be liable to the Owner for any additional costs including those charged by the Architect.

D. Contractor shall provide a written copy of all maintenance activities performed during the contract up to final acceptance of lawns.

3.8 CLEAN UP

During the contract and at intervals as directed by the Architect and as lawn work is completed, clear the site of extraneous materials, rubbish, and debris. Leave the site in a clean, safe, neat, well-draining condition.

END OF SECTION 329201

SECTION 334001 - STORM DRAINAGE

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. The extent of the storm drainage is shown on the drawings.

B. Storm drainage work includes, but is not limited to:

1. Trenching, backfilling and compaction
2. Storm structures, castings, and appurtenances
3. Piping, jointing and fittings
4. Connection(s) to other storm system(s)
5. Adjusting existing storm structures and other utilities
6. Storm Water Management Trench (SMT)
7. Quality Control Testing and Submittals
8. Clean Up

C. Provide materials, labor, equipment and services required to accomplish related work in accordance with the drawings and specifications.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 311201 - Site Preparation

B. Section 312501 - Erosion, Sediment and Pollution Control

C. Section 312201 - Site Earthwork: For Elaboration of Shoring and Bracing, Dewatering, Backfilling, Compaction and Field Quality Control Testing.

D. Section 321201 - Asphalt Paving

E. Section 321301 - Site Concrete

1.3 REFERENCES

A. ASTM D2321 Standard Practice for Underground Installation of Thermoplastic Pipe for Sewer and Other Gravity Flow Applications.

1.4 SUBMITTALS: (See Section 311201, 1.5)

A. Shop Drawings (SD) required for:

1. Precast concrete drainage structures showing sizes, elevations for openings and, HS20 loading certification.

B. Manufacturer's Product Data (MPD) required for:

1. Drainage structures and castings
2. Pipe, joints and fittings

3. Stormwater Management Trench for Pipes and Geotextiles

C. Quality Control Submittals:

1. Provide a list of completed projects including Owner's contact information for each project, demonstrating compliance with applicable "Experience Requirements" specified in "Quality Assurance" of this specification section.

1.5 QUALITY ASSURANCE

A. Drainage Contractor Experience Requirements:

1. Submit business name, business owner(s) name(s), business address, telephone number, website and/or email address signed by the Contractor/Subcontractor who meets the qualifications set forth in this specification and is proposed by the Contractor to perform the Drainage for this Project.

2. Provide a list of at least four (4) Drainage work projects of comparable size, scope and quality completed successfully by the proposed Contractor/Subcontractor within the past three (3) years that includes the date completed, project Owner's name and current contact information, including telephone numbers and email addresses.

1.6 JOB CONDITIONS

A. Job conditions in Section 312201 apply.

B. Plan and execute piping work so that trenches are not opened for more than two hundred (200') feet in advance or left unfilled more than one hundred (100') feet behind. No overnight open excavation is permitted.

1.7 SUBSTITUTIONS

A. Contractor is responsible for design of any substituted structures, systems or units in Section 334001 by a NYS licensed engineer. Submit to Architect for approval.

B. If a product is being submitted as a substitution to the specified product; the the Prime Contractor shall submit and request a product material substitution with his/her bid. The Prime Contractor shall at a minimum provide the following for review by the Architect and Owner:

1. All submittals as specified herein

2. Product comparison

3. Cost Information (including proposal of change in Contract Sum)

4. Contractor’s certification that proposed substitution complies with requirements in the Contract Documents

5. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

PART 2 - PRODUCTS

2.1 BACKFILL

A. Backfill for pipes, Stormwater Management Trenches (SMT), and drainage structures shall be as specified in Section 312201.

2.2 STORM STRUCTURES AND CASTINGS

A. Manholes:

1. Shall be precast reinforced portland cement concrete conforming to the size(s) and shape shown on drawings, designed for AASHTO HS-20 loading. The materials and structural design of the structures shall be per ASTM C478 and ASTM A497, Grade 60. The minimum compressive strength of the concrete in the structure base, riser, and top section shall be 5,000 psi. The minimum wall thickness shall be one twelfth of the internal diameter of the riser or largest cone diameter. All joints shall be waterproofed with O-ring rubber gaskets and sealed with a mastic treatment in accordance with ASTM C990. Any grout used within the system shall meet the ASTM C 1107. Manhole connector holes shall be equipped with a seal gasket that meets or exceeds material specification of ASTM C-923 or other locally approved methods. Base units shall be extended. Standard of quality shall be as manufactured by Zeiser Wilbert, Jefferson Concrete, Fort Miller or Architect approved equal.

2. Castings: Provide HS20 loading and bike safe grates, ductile iron meeting grade 65-45-12 as determined by ASTM A536-84, sizes as noted on the plans. Frames, covers and grates shall be machined to prohibit rocking. Standard of Quality shall be Neenah Foundry, East Jordan Iron Works, US Foundry, or Architect approved equal.

2.3 STORM STRUCTURE APPURTENANCES

A. Precast Concrete Adjustment Rings: Shall be square or round depending on structure. Built in accordance to ASTM C478, and made of 5,000 psi concrete and reinforced steel, meeting ASTM A615 Grade 60, as manufactured by Fort Miller, Zeiser Wilbert, Jefferson Concrete or Architect approved equal.

B. Steps: Shall be copolymer polypropylene plastic reinforced with 1/2" diameter grade 60 steel as manufactured by M.A. Industries or Architect approved equal.

C. Mortar: Shall be lime, cement, and clean sand, 1:1:3 measured by volume, meeting ASTM C1107.

2.4 PIPING

A. High Density Polyethylene Pipe (HDPE): Shall be heavy duty dual wall, high density polyethylene (HDPE) pipe conforming to ASTM F2648 for 4" to 60" pipe with a smooth inner wall, annular corrugations, "n" flow rating of 0.012, and HS-20 loading capability with minimum one (1') foot cover for 4" to 48" pipe and two (2') foot cover for 6-" pipe. Joint couplings for pipe shall be connected using a bell &spigot joint, meeting AASHTO M252, AASHTO M294, or ASTM F2306. The joint shall be soil tight and gaskets, when applicable, shall meet the requirements of ASTM F477. Standard of quality shall be N-12 Mega Green ST IB pipe as manufactured by Advanced Drainage Systems, Inc., 800-821 6710, or Architect approved equal.

2.5 STORM WATER MANAGEMENT TRENCH

A. 4" to 10" Pipe: Shall be flexible, heavy duty, corrugated interior and exterior, perforated (or slotted) polyethylene pipe meeting requirements ASTM F-667 for 4" to 10" diameters. Standard of quality shall be ADS with prefabricated snap fittings as manufactured by Advanced Drainage Systems, Inc., (614) 457-3051 or Architect approved equal. Size pipe(s) as noted on drawings.

B. 12" to 24" Pipe and Fittings: Shall be heavy duty polyethylene (HDPE), corrugated interior and exterior, perforated pipe meeting requirements AASHTO M252, AASHTO M294, Type C. Standard of quality shall be ADS with prefabricated fittings as manufactured by Advanced Drainage Systems, Inc., (614) 457-3051 or Architect approved equal. Size pipe(s) as noted on drawings.

C. 4" to 12" Fittings: Shall be injection molded fittings with a smooth interior and exterior meeting requirements AASHTO M252 for 4" to 10" diameters, and ASTM M294 or ASTM F2306 for 12" diameter. Standard of quality as manufactured by Advanced Drainage Systems, Inc., (614) 457-3051 or Architect approved equal. Size pipe(s) as noted on drawings.

D. Backfill: Shall be clean, washed No. 1 stone as indicated in Section 312201.

E. Soil Separation Fabric: Shall be a commercially manufactured non- woven polypropylene filter fabric. Standard of quality shall be Mirafi 140N as manufactured by TenCate or Architect approved equal.

PART 3 - EXECUTION

3.1 CONNECTIONS TO OTHER STORM SYSTEM

A. Connections at Building(s):

1. Locate accurately per site and plumbing drawings. Verify invert and sizes. Notify Architect of any discrepancies immediately, prior to installation.

2. Install pipe and jointing to within five (5') feet of each building exterior. Install temporary plugs, cap end, mark above grade, and protect. Coordinate with Plumbing Contractor. Connection will be made by Plumbing Contractor.

3. The Plumbing Contractor shall be responsible for connecting the building drains and leaders to the site storm system.

4. Make connections securely, watertight and as detailed. Provide all necessary couplers and fittings to make connections.

B. Connections to existing Storm Systems:

1. Coordinate with the Municipality and other agencies having jurisdiction. Notify governing agency in writing a minimum of two (2) weeks prior to anticipated date of connection so that field procedures and installation can be reviewed by a representative of the Municipality. Copy letter to Architect.

2. Locate accurately per drawings. Verify inverts and sizes. Notify Architect of any discrepancies immediately, prior to installation.

3. Make connections securely, watertight and as detailed. Provide all necessary couplers and fittings to make connections.

3.2 TRENCHING AND BACKFILL

A. Reference: Refer to Section 312201 for elaboration of shoring and bracing, supporting, rock, dewatering, and backfilling.

B. Trenching:

1. Remove material encountered to the depth shown on drawings and with a maximum width of fourteen (14") inches and a minimum of nine (9") inches each side of conduit springline as detailed. Provide safe shoring, sheeting, and bracing. Remove before backfilling. Backfill excess or over excavation as described in Section 312201 to proper line and grade. Compact to 95% density.

2. When unsatisfactory soil materials are encountered at design elevations, immediately notify the Architect in writing via email. Continue as directed by the Architect. When conditions are not a result of Contractor's negligence, additional excavation may be directed by the Architect and paid for as a Change Order on a unit price basis in accordance with specification Section 312201.

C. Water: Remove from trenches; drain trenches and/or provide sump pits and pumping equipment as necessary to keep trenches stabile and dry at no additional cost to the Owner.

D. Soft Material in Trench Bottom: Dry out and stabilize or remove and replace with imported granular backfill material to achieve firm, stable foundation at no additional cost to the Owner.

E. Rock: Remove boulders and rock within one (1'-0") foot of pipe. Provide one (1'-0") foot of granular backfill between rock and conduits at no additional cost to the Owner.

F. Backfill: Conform to details on drawings and as specified. Compact backfill to a minimum 95% of optimum density.

3.3 STORM STRUCTURES INSTALLATION

A. Pre-Cast Structures:

1. Install with corresponding extended precast base section. Precast base units shall be modified in the factory to have the correct size openings for piping.

2. Provide drainage structures as detailed, built to finished grades given. Backfill with imported granular backfill material around drainage structure and compact to 95% density to avoid settlement.

3. Mortaring: Thoroughly wet concrete risers before laying. Mortar joints. Joints shall be completely full and struck flush.

4. Install any required steps in a continuous flight, avoiding any conflict with piping.

5. Construct channels in base of storm structures for positive flow from inlet to outlet piping where detailed.

6. Build completed structure to avoid any infiltration or exfiltration of water except at underdrains or storm water management trenches.

3.4 CASTINGS

A. Provide the type specified and shown on drawings. Build to the finish grade as shown on drawings.

B. Set castings firmly. Loose or rocking castings shall be rejected by the Architect.

C. Paint all installed castings (inside and outside) with two (2) coats of black rust inhibitive paint as directed by the Architect.

3.5 ADJUSTING EXISTING UTILITIES

Adjust existing utilities as necessary to maintain utility service and meet finished grade conditions. Existing utilities include but are not limited to; hydrants, water valves, gas valves, electric pull boxes and manholes, storm drainage structures, cable and telephone markers, fiber optic cables, sanitary cleanouts and manholes, and guy wires.

3.6 PIPE LAYING

A. Shall be in accordance with ASTM D2321 and pipe manufacturer requirements.

B. Bed pipe in granular backfill or concrete as shown on drawings, compact under springline of pipe to assure firm support. Align pipe to line and grade given in plan and profile. Set batter boards or set by laser level.

C. Pipe joints shall be made using the flexible gaskets specified. Clean bell end of any debris and lubricate. Remove protective wrap from gasket. Do not allow lubricated section to touch dirt or backfill. Foreign matter could adhere to surface and compromise

joint integrity. Push together pipes so that the gasket is firmly seated in the socket. Always push spigot end into bell, not bell end into spigot.

D. Place backfill around pipes to equal depths on both sides as work progresses.

E. "Lamp" pipes to check for misalignment and breakage after backfilling has been completed. Replace pipes deviating more than 1/2" from line or grade at no additional cost to the Owner.

3.7 STORM WATER MANAGEMENT TRENCH

A. Use only pipe which is undamaged and flexible (have not been exposed to direct sunlight for more than six (6) months causing brittleness, cracking or splitting prior to placement). Pipe shall be stored for at least twenty-four (24 hrs.) hours in an area having a minimum temperature of fifty (50) degrees F.

B. Trenching: Remove material encountered to the depth shown on the drawings. Provide shoring, sheeting, and bracing as necessary for safety; remove before backfilling.

C. Install continuous envelope of soil separation fabric around the backfill up to subgrade of finish material. Fill stone to proper elevation and wrap top. Overlap fabric minimum twenty-four (24") inches at top and joints. Secure fabric joints to prevent separation and infiltration of adjacent materials and separation of fabric.

D. Install pipe sloped as shown on drawings.

E. Compact backfill to maximum density of adjacent materials.

3.8 FIELD QUALITY CONTROL

A. Density Testing: Perform all density testing for piping trenches and structure backfill as indicated in Section 312201.

3.9 CLEAN UP

A. During the contract and at intervals as directed by the Architect and as storm drainage is completed, clear the site of pipe, trench and backfill material, stone, concrete and debris. Leave the site in a clean, safe, well draining, neat condition.

B. Clean drainage structures, storm water management trenches and pipes: Clean out sediment, rubbish, construction debris, and foreign objects thoroughly, immediately prior to final acceptance.

END OF SECTION 334001