CSI: AUTOMOTIVE/AGRICULTURAL DIESEL MECHANICS FACILITY

DIVISION OF PUBLIC WORKS PROJECT NO. 22091

99% CD SET
VOLUME 2 OF 2
DIVISIONS 21 THROUGH 33

CLIENT AGENCY:
COLLEGE OF SOUTHERN IDAHO
315 FALLS AVE.
TWIN FALLS, ID 83301

CONTRACTING AGENCY:
DIVISION OF PUBLIC WORKS
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P.O. BOX 83720
BOISE, ID 83720-0072

PREPARED BY:

INTEGRUS
A COLLABORATION OF YGH & INTEGRUS ARCHITECTURE

10 SOUTH CEDAR STREET
SPOKANE, WA 99201
INTEGRUS PROJECT NO. 22220.00

JANUARY 2024

Agency Construction Approval #1 for Agency Construction Approval
2022091 - 2022091 CSI: Automotive/Agricultural Diesel Mechanics Facility, 315 Falls Ave, Twin Falls, ID 83303 USA
Tuesday, Feb 06, 2024

Agency Construction Approval

CONSTRUCTION APPROVAL BY RESPONSIBLE CHIEF OFFICER OF INSTITUTION OR AGENCY	
(IDAHO CODE 67-5710)	
Final Plans & Specs have been Reviewed for:	2022091 CSI: Automotive/Agricultural Diesel Mechanics Facility
DPW Project No.	2022091
This project incorporates the required program elements within the funding limitations authorized, and authorize the Division of Public Works to proceed with bidding of the project. If acceptable bids are received, I will approve awarding a contract and construction of the facilities in accordance with the plans and specifications.	
Agency:	CSI
Agency Signature Authority:	Jeff Harmon

Approval (Approved)

Role	Jeff Harmon (Agency - Signature Authority) Approved Jan 31, 2024 02:43 PM MST
Role	Margie Kennedy (Project Manager) Approved Feb 05, 2024 11:20 AM MST
Role	Margie Kennedy (SR PM) (Project Manager Senior) Approved Feb 05, 2024 11:28 AM MST
Role	Pat Donaldson (DPW Administrator) Approved Feb 06, 2024 12:39 PM MST

CONTENTS

VOLUME 1 OF 2

Mechanical Specifications

SECTION 21 00 00

FIRE SPRINKLERS

PART 1 - GENERAL

1.1 FIRE SPRINKER OVERVIEW

A. A double detector check valve backflow prevention assembly will be provided for the fire systems in the riser room with an exterior man door for fire department access. The (FDC) fire department connection will be remotely located (See Civil Plans). A (PIV) post indicator valve will be installed on the service line to the building and located in accordance with the State of Idaho Fire Marshal requirements.

B. The building will mostly contain Ordinary Hazard spaces associated with a repair/training facility (Shops, Storage Electrical, Mechanical, Battery Storage). Light hazard areas (offices, lecture rooms, circulation spaces) will be protected to light hazard requirements. Flammable liquid storage cabinets will be utilized to ensure quantities of hazardous materials do not exceed the (MAQ) Maximum Allowable Quantities for the building occupancy.

1.2 SCOPE OF WORK:

A. Provide all material, labor, design, and services necessary for the installation of the fire suppression sprinkler system described in the Contract Documents. This is a bidder-designed installation.

B. Scope of Work: System shall be hydraulically designed in accordance with the currently adopted version of NFPA 13 and the following. Operating areas shall be as specified in NFPA 13.
   1. Shop, storage rooms, mechanical rooms, electrical rooms shall be designed for an ordinary hazard spacing and density.
   2. Classroom areas shall be designed in accordance with NFPA 13, Light Hazard.
   3. Area reduction for quick response heads as described in NFPA 13 is allowed. Area reductions shall adhere to specific height restrictions.
   4. Seismic Loops will be added to piping network at building Expansion Joints as required per NFPA 13.
   5. System main piping shall be sized to accommodate future expansion (per plan notes).

C. For hydraulic calculations, a margin of 10% between demand points and the water supply is required. Available water supply for design calculations, a copy of recent flow test will be required for submittal (within 12 months of design submittal).
   1. Flow Test report 06/27/23. Static 80+psi (See section 3.9 Below)

1.3 QUALITY ASSURANCE

A. Qualifications:
1. Qualifications of Contractor: All work shall be performed by a Contractor with a valid Idaho state Contractor's license for the installation of fire sprinkler systems, and local Authority Having Jurisdiction (AHJ) certification for the design and installation of fire suppression sprinkler systems.
2. The system shall be designed by a NICET Level 3 sprinkler designer, or a registered fire protection engineer or mechanical engineer (who must review and stamp all drawings and the hydraulic calculation cover sheets).
3. The field installation shall be supervised at all times by a journeyman sprinkler fitter or person with equivalent experience.
4. All work shall comply fully with applicable codes and standards. Nothing in the contract documents shall be construed to permit non-compliance with any other code or standard
5. Warranty: The contractor shall guarantee all materials, equipment, and workmanship in this installation period of one year from the date of completion. Any system failure during that time shall be repaired at the contractor's expense. The contractor shall respond on site to system problems within 24 hours.
6. All grooved joint couplings, fittings, valves, and specialties shall be of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
7. All castings used for fittings, couplings, valve bodies, etc., shall include a cast date stamp for quality assurance and traceability.

B. Codes and Standards: The design and installation shall conform to the latest edition, based upon local jurisdiction adoptions and amendments at the time of bid, of each of the following:
1. 2021 IBC with additions, deletions, and exemptions per Idaho State Building Code
2. 2021 International Fire Code with additions, deletions and exemptions per Idaho Fire Code
3. NFPA 13 (2019), "Standard for the Installation of Sprinkler Systems," including all appendices

1.4 APPROVALS:

A. Authority Having Jurisdiction: For purposes of code compliance, the Authority Having Jurisdiction (AHJ) for this installation will be the Idaho State Fire Marshal. Where there are conflicts between the AHJ and the referenced codes and standards, the more stringent shall apply.

1.5 SUBMITTALS

A. Prepare and submit CAD Shop Drawings, product data. Include:
1. Hydraulic calculations, seismic brace calculations, and all items set forth in NFPA 13.
2. Product data and samples including a complete list of equipment and products, and a manufacturer's catalog sheet for each item to be included in the work.
3. Sprinklers shall be referred to on drawings, submittals, and other documentation, by the sprinkler identification or model number as specifically published in the

appropriate agency listing or approval. Trade names or other abbreviated designations shall not be allowed.

4. Material Submittals: Concurrent with submittal of shop drawings, furnish to the A/E in pdf format a complete list of annotated equipment and products, and a manufacturer's catalog sheet for each item to be included in the project.
5. All material submittals shall include all items listed in the product section of this specification and all additional items necessary to provide a complete installation. Where more than one item appears on a manufacturer's catalog sheet, the item or items to be used shall be indicated.
6. Shop Drawings: At least 15 working days prior to any installation or fabrication of the system components, the Contractor shall submit in pdf format shop drawing and hydraulic calculations to A/E for review by the A/E. The A/E will review the submittals and make pertinent comments. The contractor will then make any necessary corrections and submit them for reconsideration/approval.
7. Shop drawings shall conform to and include all items as set forth in NFPA 13; 23.1 Working Plans.
8. After submitting shop drawings to the A/E and Owner for review, the Fire Sprinkler Contractor and the General Contactor shall hold an on-site meeting to review the shop drawings and potential fire sprinkler pipe installation locations. This meeting shall occur during the A/E shop drawing review process, before submitting to the State Fire Marshal for approval.
9. After approval is received from the A/E, submit shop drawings to the AHJ for approval. Submit evidence of final drawing approval by the AHJ to the A/E prior to the start of fabrication or installation.

B. For Substantial Completion, submit (changes clouded) as-built CAD Shop Drawings, and O&M information required manufacturers product data catalog sheets and a completed Contractor's Test and Materials Certificate.
   1. Acceptance of the completed work will be granted jointly by the local AHJ. Approval by the local AHJ shall be evidenced in writing and forwarded to A/E as a requirement for Substantial Completion.
   2. Close-out Documentation: Submit fire suppression NFPA13; Contractor's Test and Materials Certificate.
   3. Record Drawings: Show changes and deviations from the Drawings. Include issued Addendum and any change order items.
   4. At the conclusion of the project, provide two (2) sets of as-built drawings, two (2) virtual copies of drawings in pdf and AutoCAD format, two (2) operations & maintenance manuals in pdf and hardcopy for all installed equipment and devices and two (2) copies of NFPA 25. to the A/E for turning it over to the owner representative.

PART 2 - PRODUCTS

2.1 GENERAL

A. Materials and equipment: All materials and equipment in the system shall be new and current products of a manufacturer regularly engaged in the production of such materials and equipment. Where two or more pieces of equipment are required to perform interrelated functions, they shall be products of one manufacturer.

B. Approval guides: Unless otherwise indicated, all products shall be listed in the latest publications of Approval Guides for Underwriters Laboratory for the service intended.

C. Pressure rating: Pressure ratings of all fittings shall meet or exceed maximum working pressures available within the system.

D. Corrosion protection: All piping and hangers, where exposed to the weather or installed in corrosive atmosphere, shall be protected against corrosion. Piping and hangers in such areas shall be stainless steel and/or hot dipped galvanized. Piping having an external only galvanized finish in such areas is not acceptable.

2.2 PIPE

A. Schedule of pipe: All pipes shall be ferrous and meet the requirements of NFPA 13. Pipe shall be schedule 40 for threaded and cut groove pipe and schedule 10 for roll groove applications. No substitutions.

2.3 FITTINGS AND COUPLINGS

A. Threaded fittings: Threaded fittings shall be ductile or cast-iron class 125, rated for 175 psi cold water working pressure and shall conform to ASME B16.4, and ANSI B2.1 NPT. Malleable threaded fittings are not acceptable.

B. Nipples: No close nipples are allowed. For short pipe connections use standard short nipples.

C. Thread-O-Lets: Shop-welded Thread-O-Lets may be used where a certified welder is used, meeting the requirements of this Section.

D. Plain end couplings: No plain end couplings (Roust-A-Bouts, Plainloks or similar couplings) are allowed.

E. Hole-cut outlets: No hole-cut outlets are allowed for new sprinkler systems. Hole-cut bolted outlets (mechanical tees) couplings may be used only in isolated locations of existing sprinkler systems, when approved by MW Engineers. Coupons created by hole-cut outlets shall be secured to the fittings via zip-tie or wire.

F. Flexible drops: UL listed flexible drops up to 6 feet in length are permitted where installed in accordance with NFPA 13 and manufacturer's requirements.
   1. Flexible drops may only be used on hydraulically designed systems.
   2. The drop shall include a UL approved Series AH2 braided hose with a bend radius to 2" to allow for proper installation in confined spaces. Union joints shall be provided for ease of installation.
   3. The flexible drop shall attach to the ceiling grid using a UL Listed bracket. The bracket shall allow installation before the ceiling tile is in place.
   4. Victaulic VicFlex™ Multiple-Use Flexible Stainless-Steel Sprinkler Drop System or approved equal.

2.4 PIPE THREAD SEALANT

A. Provide Teflon tape or brush-on pipe thread sealant with Teflon. Provide Grinnell Tuff-Loc, or approved equal.

2.5 HANGERS AND SUPPORTS

A. Hangers: Provide hangers to support all piping in perfect alignment without sagging or interference, to permit free expansion and contraction, and to meet the requirements of NFPA 13.

B. Pipe rings: Pipe rings shall be Tolco Fig. 200 or approved equal. Branch line restraint to be provided.

C. Hanger rods: Hanger rods shall be zinc or electro-galvanized for dry systems.

D. C-clamps: Equip all c-clamps (beam clamps) with earthquake retaining straps.

2.6 VALVES

A. Outside screw and yoke (OS&Y) valves: OS&Y valves shall be cast iron, grooved or flanged and rated for 175 psi, non-shock cold water working pressure. Victaulic Series 771 or approved equal.

B. Isolation/control valves: Sprinkler system, standpipe, and other approved ground controlling valves shall be gear-operated slow-close butterfly valves with flag type indicator, ductile iron grooved body, EPDM pressure responsive seat, electroless-nickel coated disc, stainless steel stem with bronze bushings, and two internal single-pole, double-throw monitor switches. Victaulic Series 705 or approved equal.

C. Supervised valves 1 ½ inches and smaller: Sprinkler controlling valves 1 ½ inches and smaller shall be slow-close supervised butterfly valve from Milwaukee Valve Company, model BB-S02-R, or approved equal. Valves controlling fire sprinklers in elevator pits shall be unsupervised.

D. Drain valves: Drain valves need only be UL Listed, screw-in bonnet bronze globe valves, rated to 175 psi non-shock cold water working pressure by Nibco, United, or approved equal. Low point drain valves shall have, in addition, a 3/4-inch brass nipple with 3/4-inch mail hose threads and cap.

E. Combination test and drain valve: Victaulic Style 720 TestMaster II or AGF Model 1000 Test ’N Drain assembly or approved equal. Pressure gauge for system pressure located on test and drain assembly is not acceptable for measuring system pressure.

F. Check valves: Check valves shall be grooved, iron body, bronze seat, elastomer coated ductile iron or stainless-steel clapper with a replaceable rubber seal (a rubber seal integral with the seat is not acceptable), and minimum 175 psi non-shock cold water working pressure. Use Victaulic Series 717, Viking Model D, or approved equal.

G. Backflow prevention assemblies (In Riser room). The assembly shall be listed in the most recent Idaho State Department of Health Approved. Backflow prevention assemblies shall be by Febco, Ames, Watts, or approved equal.

H. Wafer valves are not acceptable.

I. Air Venting: A single air vent valve installed at or near a high point in the system conforming to NFPA 13, shall be provided on each wet pipe zone.

J. Bidder Note: 1” combination, ganged Air Relief line is planned at the high side of building. Remote Inspectors test location is required to exhaust air from these air trapped branchlines.

2.7 SPRINKLERS

A. Provide quick response white sprinklers throughout.

B. For lay-in suspended and gypsum wall board ceilings, provide intermediate temperature, standard coverage, recessed sprinklers.

C. For all other building areas, sprinkler heads shall be quick response, glass bulb, intermediate temperature, standard coverage. Provide upright, pendant, or sidewall heads to meet building conditions.

D. Pendent sprinklers in ceilings shall be white with white escutcheons. Provide “401” type canopies only in small rooms with surface-mounted obstructions, (example-surface mounted lights in stairway).

E. Sprinklers in unfinished areas shall be brass.

F. Spare Sprinklers: Provide spare sprinklers and escutcheons for each type and style of sprinkler used in accordance with NFPA 13 and proportioned based upon the number of each type and style of sprinkler used on the project.

2.8 SPRINKLER GUARD

A. Provide UL Listed sprinkler guards for sprinkler heads lower than 7’ 0” above the floor.

B. Guards and escutcheons shall be listed, supplied, and approved for use with the sprinkler by the sprinkler manufacturer.

2.9 FIRE DEPARTMENT CONNECTION

A. Provide a fire department connection (FDC) with horizontal type connections, dual clapper, 2-1/2-inch inlets, with rocker lug caps, and chains. The FDC / escutcheon shall be polished brass. (Coordinate hose threaded connections with Fire Department)

B. FDC signage: Provide signage indicating “AUTO SPRINKLER” part of the FDC escutcheon.

C. Locate fire department connection per responding fire department requirements. Show location of fire hydrant on Fire Sprinkler Submittal drawings.

2.10 SIGHT DRAIN

A. Where required, provide a single piece sight drain.

2.11 PRESSURE GAUGE

A. Provide a 3-1/2 inch diameter, bourbon type pressure gauge, 0-300 lbs, and 1/4 inch soft metal seat globe valve with arrangements for draining pipe between gauge and valve, located near each main or floor control valve assembly on the main line or near each test location.

2.12 SPLASH BLOCK

A. If main drain is not located over a hard surface (Concrete, Asphalt), provide a splash block at the point of discharge to the outside of the building.

2.13 SLEEVES

A. Provide 24-gauge galvanized sheet metal with lock seam joints or 1/2-inch overlap sleeves in floors, partitions, ceilings, and in construction without waterproof membranes. Provide schedule 40 galvanized steel pipe sleeves in exterior walls. Provide schedule 40 pipe sleeves with clamp rings in slab-on-grade or exterior walls having below grade penetrations. Provide sleeves through roofs with flashing collars.

2.14 WALL ESCUTCHEON

A. For exposed pipe installations, provide plastic split ring type escutcheons and paint to match wall.

2.15 SIGNS

A. Provide all control, drain and test valves with signs identifying the type of valve, the area (floor or portion of the building) affected by the valve. Signs shall be three-layer etched plastic with red letters on a white background. Letters shall be a minimum of 1/4 inch high. The signs are to be hung by chain from the valve. If the system is a hydraulically calculated system, provide a sign in accordance with NFPA 13.
   1. Submit text for approval (ex., “CONTROL VALVE FOURTH FLOOR NORTH”)

2.16 SPARE PARTS AND TOOLS

A. The Contractor shall provide spare sprinklers for maintenance. Minimum quantity of sprinklers required by NFPA 13, for each type, finish, and temperature rating used in the Work.
   1. Provide to maintenance team for safe keeping.

B. The Contractor shall provide two (2) sprinkler wrench compatible with each type of sprinkler provided for spare sprinkler cabinet.

PART 3 - EXECUTION

3.1 GENERAL

A. Standards and requirements: Perform all installation work in accordance with the reference standards without exception, and as required by AHJ. Install all piping straight, true and plumb.

B. Changes to the approved Shop Drawings: Before making substantive deviations from the approved Shop Drawings, obtain written approval from the A/E and the AHJ. Carefully note any deviations on the Project Record.

C. Grooved joint couplings and fittings shall be installed in accordance with the manufacturer's written installation instructions. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Gaskets shall be verified as suitable for the intended service prior to installation. Gaskets shall be molded and produced by the coupling manufacturer. The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and installation of grooved joint products. The manufacturer's representative shall periodically visit the jobsite and review installation. The contractor shall remove and replace any joints deemed improperly installed.

3.2 PENETRATIONS

A. Required clearance around pipe: Provide piping that passes through fire rated assemblies, including fire rated GWB assemblies, with clearance around the entire circumference of the pipe as required by NFPA 13. Penetrations of walls, floors or ceilings shall be made in a neat manner using properly sized hole-saw or masonry/concrete coring as necessary.

B. Fire rated assemblies: The annular space between the wall or pipe sleeve and the sprinkler pipe in fire rated assemblies shall be filled with UL classified fire-stopping material in accordance with the manufacturer's recommendation.

C. Escutcheons: Where exposed piping or hangers pass through a finished floor, wall or ceiling, install split wall plates or escutcheons fitting securely and snugly and covering the opening.

3.3 CONTROL VALVES

A. Install all control valves, supply valves, and test valves in easily accessible locations with the valve handle, or wheel, no higher than seven (7) feet above the finished floor.

3.4 WATER FLOW SWITCHES

A. Install all water flow switches in easily accessible locations, such that the cover plate is unobstructed and facing forward.

3.5 INSPECTOR'S TEST AND DRAINS

A. Provide inspector's test valves for each floor of each system.
   1. Remote inspector's test assembly shall be piped to discharge outside the building and shall be located at the hydraulically most remote part of the system.

B. Main drains: Provide main drain to exterior. The location shall be capable of accepting the full flow of the sprinkler system main drain. Do not pipe any sprinkler systems directly into a drain. There must be at least a 1/2 inch gap between the pipe and the funnel/drain.
   1. For single story buildings, drain risers and main drain shall discharge to a safe location outside the building. Provide splash blocks to limit damage to landscaping.
   2. Where outside discharge cannot be achieved, discharge shall be a drain riser.

C. Auxiliary drains: Provide auxiliary drains at all low points of the system, where the trapped section of pipe exceeds 5 gallons.
   1. The drain shall consist of, as a minimum, a valve, a 3/4 inch brass nipple with 3/4 inch male hose threads, and cap.
      a. Locate auxiliary drains in unfinished areas, without suspended ceiling, whenever possible.
      b. When located in finished areas, with lathe and plaster or GWB locate the hose bib within six (6) inches of an access panel, minimum 12" x 12". When located in toilet rooms the panel shall be stainless steel.

3.6 GAUGES

A. Provide gauges at the main system riser and at each floor control valve.

3.7 LAY-IN SUSPENDED CEILINGS

A. When not indicated otherwise, locate sprinkler heads between the one-quarter and three-quarter points of the tiles in both directions and carefully align them.

B. Provide 1 inch clearance with escutcheon around penetrations through suspended ceilings per ASCE requirements.

3.8 INSPECTION AND HYDROSTATIC TESTS

A. Hydrostatic testing of aboveground piping: Install aboveground piping in such a manner that there will be no visible leakage or drop in gauge pressure when the system is subjected to the hydrostatic pressure test. The test shall be in conformance with NFPA 13 . The Contractor shall repair any leaks or drips immediately. Do not use additives and corrosive chemicals, sodium silicate or derivatives of sodium silicate, brine, or other corrosive chemicals for testing systems or stopping leaks.

B. Inspection of piping before installation of wall/ceiling material: Piping, hangers and sway bracing shall be considered satisfactorily installed when the installation is in conformance with the Contractor's approved Shop Drawings and NFPA 13. The Owner and the local AHJ shall approve any deviations from the approved Shop Drawings. When in the opinion of the Owner or the local AHJ representative, the installation deviates greatly from the approved Shop Drawings, revised Shop Drawings and hydraulic calculations may be required to verify the installation.

C. Partial system test or sprinkler coverage inspections: Perform tests with the sprinklers installed in their final positions. Where it is critical to the continuance of the project as a whole to cover portions of the piping with ceilings or walls prior to the completion of the entire system, perform partial testing of the system after receiving written approval from the A/E. In this case "partial" indicates an entire zone of floor of one system. A satisfactory partial test does not relieve Contractor from performing all final testing procedures.

D. Final piping inspection: Final sprinkler placement shall be considered satisfactorily complete when all sprinkler heads are installed in accordance with their listing or AHJ approval and the Contractor's approved Shop Drawings. The Contractor may be required to relocate or add additional sprinklers if proper coverage is not provided due to unforeseen or modified architectural conditions.

E. Final functional test: The final functional test shall be considered satisfactorily complete when all valves and switches perform in accordance with the Contractor's approved Shop Drawings and the following procedures:
   1. Operate all control valves to verify proper operation of the valve and associated tamper switch.
   2. Operate all test connections to verify water-flow switch operation.

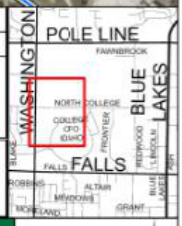
F. Inspection and test results should be forwarded to the Owner. Should the results of any inspection or test not be satisfactory to the Owner or AHJ, a written list of corrective work items will be provided to the Contractor. The Contractor shall make the required corrections and request re-inspection as a requirement for Substantial Completion.

3.9 AVAILABLE WATER ON SITE

CASE 1 Max Day Demands

Modeled fireflow and pressure of select junctions

ID	Static Demand (gpm)	Static Pressure (psi)	Fireflow (gpm)	Residual Pressure (psi)
J-111	12.7	83.8	2,500	80.0
J-4379	0.0	81.8	2,500	78.4
J1808	0.0	83.1	2,500	79.3



J-U-B ENGINEERS, INC.

North CSI
Water Flow Analysis

0 75 150 300
1 inch = 300 feet
N

END OF SECTION

SECTION 22 05 00

COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 CONDITIONS AND REQUIREMENTS

A. Refer to Divisions 00 & 01 of these specifications, which govern work under Division 22. Refer to other sections of these specifications for additional related requirements.

1.2 SCOPE OF REQUIREMENTS

A. The work covered by Division 22 of the specifications shall include but not limited to furnishing all materials and supplying all labor, equipment, and services to install the complete Division 22 systems as shown on the accompanying drawings and specified herein.

B. Work done under Divisions 22 of the specifications shall comply with the requirements specified herein.

1.3 ALTERNATES (REFER TO DIVISION 00)

A. The bid price for each alternate shall include a complete working Division 22 system as described in the alternates, shown on the drawings, and indicated in these specifications.

1.4 CODES, PERMITS AND FEES

A. Division 22 work shall be in accordance with the following as adopted by the governing agencies, including amendments:
1. Americans with Disabilities Act (ADA)
2. Applicable State and Local Codes and Ordinances
3. National Electrical Code
4. International Building Code
5. International Fire Code
6. International Mechanical Code
7. Idaho State Plumbing Code
8. International Energy Conservation Code (With Idaho Amendments)
9. International Fuel Gas Code

B. Permits and inspections required for the Division 22 work on this project shall be obtained as part of the Division 22 scope of work, and the cost for these permits and inspections shall be included in the Division 22 bid. All inspection certificates shall be delivered to the Owner's Representative prior to final acceptance of the work in accordance with the requirements of these specifications.

C. Work shall comply with all regulations associated with all applicable utilities.

1.5 INTENT AND INTERPRETATIONS

A. It is the intent of these plans and specifications to result in a complete and working Division 22 installation in complete accordance with all applicable codes and ordinances.

B. The drawings and these specifications are intended to supplement each other. Any details contained in either the drawings or these specifications shall be included as if contained in both.

C. Items not specifically mentioned in the specifications or noted on the drawings, but which are obviously necessary to make a complete working installation shall be included.

1.6 DEFINITIONS

A. The term “Acceptance”, when used in Division 22, shall be defined as the Owner’s assumption of ownership for part or all of the Division 22 system. Acceptance of part or all of the Division 22 system, when granted prior to completion of Division 22 work and/or correction of deficiencies, shall not relieve Division 22 of any responsibility for completion of this work and/or correction of these deficiencies.

B. The term “Date of Acceptance”, when used in Division 22, shall be the official date when Acceptance, as defined in these specifications, occurs. The Date of Acceptance shall be assumed to coincide with granting of Substantial Completion unless noted otherwise by the Owner’s Representative. Deviation of the Date of Acceptance from Substantial Completion can assume to have occurred only when written documentation is provided by the Owner’s Representative specifically indicating this separation and identifying an alternative designation for the Date of Acceptance.

C. The terms “The Contractor” or “This Contractor”, when used, shall be defined as the Contractor responsible for Division 22 work.

D. The term “Owner’s Representative”, when used, shall refer to the Architect or their designated representative in accordance with Division 00 and 01.

E. The term “Provide” shall mean furnish and install.

F. The term “Mechanical”, when used, to distinguish a particular scope of work or portion of the documents, shall mean the Division 22 scope of work and Division 22 documents (drawings and specifications) respectively.

1.7 DRAWINGS

A. Plumbing/Mechanical drawings show general arrangement of piping, ductwork, equipment, etc. Drawings shall be followed as closely as actual building construction and work of other trades will permit.

B. Architectural and Structural drawings and specifications shall be considered part of this work insofar as they furnish information relating to design and construction of the building. These documents take precedence over Division 22 drawings and specifications if any dimensional discrepancies exist.

C. Division 22 drawings are diagrammatic only. Consequently, all required duct and pipe offsets are not indicated on the drawings. Offsets as required to meet the design intent of the drawings shall be provided.

1.8 GUARANTEE (REFER TO DIVISIONS 00 AND 01)

A. The Division 22 equipment, materials, and installation shall be guaranteed for a period of one (1) year unless an individual item or specification is otherwise noted as longer. All defects in Division 22 work and/or equipment furnished that develop at any time during the one year guarantee period shall be corrected at no cost to the owner, including any expenses for cutting, patching, and repairing made necessary by corrections of unsatisfactory work and/or damage resulting from incorrect equipment operation.

B. Permission to use the permanent Division 22 system for temporary heating during construction does not constitute acceptance. All product and system warranties shall be extended at no cost to the Owner as required to maintain this one (1) year requirement from the Date of Acceptance if such permission is given.

C. Equipment warranties in addition to this guarantee shall be provided in accordance with the table at the end of this section.

1.9 COST BREAKDOWN

A. Refer to Divisions 00 and 01 for supplemental requirements.

B. A breakdown of the plumbing construction cost shall be furnished to the Owner’s Representative within 30 days of Notice to Proceed, with separate costs for each of the items listed in the cost breakdown identified in Part 4 at the end of this section.

1.10 PAYMENT REQUESTS

A. Refer to Divisions 00 and 01 for supplemental requirements.

B. Payment requests for materials will only be available if the materials are stored in alignment with DPW’s requirements.

1.11 USE OF EQUIPMENT DURING CONSTRUCTION

A. The mechanical room and air handling unit equipment shall not be used to store construction or waste materials.

B. Temporary heating for the facility during the construction phase shall not be supplied by the permanent system installed under Division 22 unless Contractor shall obtain a letter

of approval from the Owner stating that they understand equipment expected life may be shortened due to severe usage.

C. If the Contractor is given permission to use permanent systems for space heating during construction:
   1. Product warranties shall be extended as required to account for construction use. Warranty periods offered by equipment manufacturers and/or required by these specifications shall begin at the Date of Acceptance. If equipment manufacturers require that the warranty period begin with use of equipment during construction, the Contractor shall bear the expense of extending all such warranties to maintain the required warranty period beyond the Date of Acceptance.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS – STANDARDS AND CODES

A. Materials used under this Contract, unless specifically noted otherwise, shall be new and of the latest and most current model line produced by the manufacturer. Outdated “new” equipment is not acceptable. Each item of equipment and material shall conform to the latest Standard Specifications of the American Society for Testing Materials and shall conform to any applicable standards of the United States Department of Commerce.

B. Motor and equipment name plates as well as applicable UL and AGA labels shall be in place when Project is turned over to the Owner.

C. Motor efficiencies shall meet or exceed the requirements of the applicable energy code.

D. All electrically driven or connected equipment shall be provided with UL or equivalent label and/or listing in accordance with the requirements of the NEC.

E. Equipment shall be UL listed as an assembly where listing/labeling program is available for that type of equipment.

F. All control panels shall be provided with UL or equivalent label and/or listing in accordance with the requirements of the NEC and applicable local electrical codes.

G. Fuel fired equipment shall be listed by a nationally recognized testing laboratory for use with the particular fuel type.

H. All pressure vessels and relief valves shall be furnished in accordance with applicable State Boiler and Unfired Pressure Vessel Laws. This shall include rating and stamped in accordance with the ASME Boiler and Pressure Vessel Code where required by Code authorities or State Law.

I. All piping, fittings, valves, fixtures, faucets and equipment containing or conveying potable water shall comply with the latest US Safe Drinking Water Act mandating any wetted surface of the above mentioned items shall not contain above 0.25% lead content by weighted average. All piping, fittings, valve and equipment containing or conveying potable water shall comply with NSF 61 G and NSF 372 or shall be provided with indication on submittals the manufacturer’s declaration of self-certification.

2.2 EQUIPMENT/MATERIAL SUBSTITUTIONS

A. Throughout these specifications and drawings, various materials, equipment, apparatus, etc., are specified or scheduled by manufacturer, brand name, type or catalog number. Such designation is to establish standards of desired quality and construction and shall be the basis of design and the bid.

B. Substitutions will not be permitted without written approval. (Refer to Divisions 00 and 01.)

C. Where two or more manufacturer designations are listed in these specifications, choice will be optional with the Contractor except that where more than one manufacturer is listed and only one manufacturer's catalog number is specified or only one manufacturer scheduled on the drawings (basis of design), that standard of quality, dimensional characteristics, capacities, and construction shall be maintained by materials or equipment supplied by the other manufacturer(s).

D. Substituted equipment with efficiencies less than 99% of the basis of design efficiency shall not be considered equal to the basis of design.

E. If the Division 22 Contractor uses manufacturers other than the basis of design, the Contractor shall be responsible for:
   1. Insuring the substituted item will fit the available space while allowing proper maintenance access
   2. Any changes required by other Contractors caused by the substituted equipment
   3. Changes in electrical requirements: See "Equipment Substitutions – Electrical Characteristics" below
   4. Changes in structural design due to weight differences

F. In the event other than specified equipment is used and will not fit job site conditions, this Contractor shall assume responsibility for replacement with items indicated as the basis of design.

G. Substitutions not approved during bid will not be accepted.

2.3 EQUIPMENT SUBSTITUTIONS – ELECTRICAL CHARACTERISTICS

A. Products furnished other than the basis of design shall have similar electrical characteristics as the scheduled or specified equipment. The Contractor shall be responsible for any electrical changes caused by products not in accordance with this requirement.

2.4 SUBMITTALS FOR REVIEW

A. Refer to Divisions 00 and 01 for supplemental requirements.

B. Shop drawings, catalog information and material schedules shall be submitted for approval on all specified materials and equipment in Division 22 prior to ordering.

C. The Contractor shall create a comprehensive submittal list of all Div. 22 equipment, piping, accessories, and more that shall be submitted on. The comprehensive list shall be sent to the Engineer prior to starting the submittal process for approval.

D. Provide specific wiring diagrams for all equipment requiring electrical or control wiring. Upon approval, copies of these diagrams shall be forwarded to pertinent contractors.

E. Furnish complete shop drawing/catalog data for equipment and materials to be used in the work for review. Allow sufficient time for developing shop drawings, processing and review time so that the installation will not be delayed.

F. Shop drawings shall be reviewed, approved and stamped by the Contractor prior to submitting to Owner's Representative for approval. Submittals without such approval will be returned without review.

G. Where choices of options and accessories are available or specified, provide written description of what is to be furnished. If necessary, list page numbers where submitted items are described.

H. State sizes, capacities, brand names, motor horsepower, electrical characteristics, accessories, materials, gauges, dimensions, and other pertinent information.

I. Underline applicable data.

J. If material or equipment is not as specified or submittal is not complete, it will be rejected. Only complete submittal including all applicable specification sections will be reviewed.

K. Field applied adhesives, sealants, fillers, primers, glues, and paint shall meet or exceed the requirements as identified in part 3 of this section.

L. Provide cut sheets and a Material Safety Data Sheet (MSDS) for each field applied sealant, adhesive, coating, paint etc used in the building, highlighting VOC limits and chemical component limits. Also indicated in additional to actual VOC emissions identify allowed limits of each product to demonstrate compliance. Submit all proposed field applied products as a single submittal for review with their MSDS data.

M. Catalog data or shop drawings for equipment which are noted as being reviewed shall not supersede Contract Documents.

N. Review comments shall not relieve the Contractor from responsibility for deviations from Contract Documents unless attention has been called to such deviations in writing at time of submission, nor shall they relieve this Contractor from responsibility for errors in items submitted.

O. Check work described by catalog data with Contract Documents for deviations and errors.

P. Shop drawings and submittal information shall be provided for all required Division 22 equipment. All Division 22 sections shall have a dedicated submittal and shall include all products with the section. Incomplete submittals will be rejected without review.

Q. Submittal Format:
   1. Electronic submittals shall be provided with accordance with all of the following conditions. Electronic submittals which do not comply with all of these conditions will be rejected without review.
      a. Electronic submittals shall be submitted in the current version of Adobe Portable Document Format (PDF)
      b. Submittals shall be original PDF's of the document and shall not be created using scanned copies of paper documents.
      c. PDF documents shall be searchable.
      d. PDF documents shall be unlocked
      e. Electronic submittals shall be separated by specification section and identified as such. Submittals which combine multiple sections into a single document will be rejected.
      f. Electronic submittals shall include a table of contents and each applicable section shall be bookmarked for easy access.
      g. Electronic submittals shall be clearly marked in RED using boxes and arrows and other appropriate markings to indicate specific product information, option selections, accessories, etc.

R. Each product shall be keyed to the paragraph number in the specifications.

S. Operation and maintenance data for individual equipment shall also be provided subsequent to approval of equipment submittals in a separate binder meeting the same requirements as the submittal binder. Refer to Part 3 of this section for supplemental requirements.

T. All submittals and re-submittals as required shall be provided with a cover page incorporating a table similar to that provided at the end of this section. The appropriate box(es) shall be checked on each line item for all submittals.

PART 3 - EXECUTION

3.1 LOCATIONS

A. Coordination of Division 22 equipment and systems to the available space, with other trades and to the access routes through the construction shall be the Contractor's responsibility.

B. Drawings are diagrammatic. Make offsets, transitions, and changes in direction of pipes and ducts as required to maintain proper head room and pitch of sloping lines and avoid structural, electrical, pipe and duct interferences whether or not indicated on Drawings. Furnish fittings, etc., as required to make these offsets, transitions and changes in direction at no additional cost to the Owner.

C. Pipe and duct routing shall be coordinated and verified with all trades prior to fabrication and installation. Additional project costs resulting from failure to do so shall be the Contractor's responsibility.

D. Determine exact route and location of each pipe and duct and coordinate and obtain approval for changes from the layout indicated on the drawings with the Owner's Representative prior to fabrication.

E. Locations of equipment and devices, as shown on the drawings, are approximate unless dimensioned. Verify the physical dimensions of each item of Division 22 equipment to fit the available space and promptly notify the Owner's Representative prior to roughing-in if conflicts appear.

F. All piping, wiring, equipment, ductwork, tubing, etc., shall be concealed within building construction unless otherwise noted, or in mechanical rooms.

G. Arrange pipes, ducts, and equipment to permit ready access to valves, unions, traps, trap primers, starters, motors, control components, and to clear openings of doors and access panels.

3.2 SCHEDULING

A. It is understood that while drawings are to be followed as closely as circumstances permit, the Contractor shall be responsible for installation of systems according to the true intent and meaning of Contract Documents. Anything not clear or in conflict will be explained by making application to Owner's Representative. Should conditions arise where certain changes would be advisable, secure approval from Owner's Representative for those changes before proceeding with work.

B. The contractor shall coordinate with the work of various trades when installing interrelated work. Before installation of Division 22 items, proper provisions shall be made to avoid interferences. Changes required in work specified in Division 22 caused by neglect to do so shall be made at no cost to Owner.

C. Supports and inserts in concrete required for Division 22 supports shall be furnished and installed in the Division 22 scope unless otherwise noted. Furnish sleeves, inserts, supports, and equipment that are an integral part of other Divisions of the Work to those involved in sufficient time to be built into construction as the Work proceeds. Locate these items and see that they are properly installed. Expense resulting from improper location or installation of items above shall be borne under Division 22.

3.3 CUTTING AND PATCHING

A. All cutting and patching of new and existing construction required for the installation of systems and equipment specified in Division 22, including patching of existing walls, floors, and roofs upon removal of existing Division 22 systems and equipment, shall be the responsibility of the Division 22 Contractor. All cutting shall be accomplished with masonry saws, drills or similar equipment to provide neat uniform openings.

B. Walls, floors, ceilings and roof shall be patched and repaired with materials of same quality and appearance as adjacent surfaces unless otherwise shown. Surface finishes shall exactly match existing finishes of same materials. All patching shall meet the approval of the Owner's Representative.

C. All cutting and patching made necessary to repair defective equipment, defective workmanship or be neglect of this Contractor to properly anticipate their requirements shall be included in Division 22.

D. Cut carefully to minimize necessity for repairs to existing work. Do not cut beams, columns, or trusses or other structural members without the Owner Representative's written approval.

E. Cutting, patching, repairing, and replacing pavement, sidewalks, roads, and curbs to permit installation of work specified or indicated under Division 22 is responsibility of Division 22.

3.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Refer to Divisions 00 and 01 for supplemental requirements.

B. Follow manufacturer's directions in delivery, storage, protection, and installation of equipment and materials.

C. Promptly notify Owner's Representative in writing of conflicts between requirements of Contract Documents and Manufacturer's directions and obtain written instructions from Owner's Representative before proceeding with work. The Contractor shall bear expenses arising from correcting deficiencies of work that do not comply with manufacturer's directions or such written instructions from Owner's Representative.

D. Deliver equipment and material to site and tightly cover and protect against dirt, water, and chemical or mechanical injury but have readily accessible for inspection. Store items subject to moisture damage (such as controls) in a dry, heated space.

E. Notify Owner of equipment delivery dates twenty-four (24) hours in advance of delivery.

F. The Contractor shall be responsible for protection of equipment furnished in Division 22 from vandalism and weather during all phases of construction. Damaged equipment shall be restored to like new condition or replaced at the Contractor's expense.

G. Any factory painted equipment scratched or marred during shipment or construction shall be restored to original "new" condition. This includes complete repainting if necessary to provide exact paint match.

3.5 VISITING THE PROJECT SITE

A. The premises shall be examined and conditions shall be understood which may affect performance of work of Division 22 before submitting proposals for this work.

B. No subsequent allowance for time or money will be considered for any consequence related to failure to examine existing site conditions.

3.6 TESTS

A. See individual specification sections for Testing Requirements.

3.7 EXCAVATION AND BACKFILL

A. Comply with Division 31 and the requirements of this section.

B. Provide all necessary excavation, shoring, bedding and backfilling required for the installation of work specified and indicated under Division 22. This shall include but not be limited to piping, tanks, vaults, drywells, catch basins, manholes and other miscellaneous items inside building premises or outside as may be necessary.

C. Compaction testing shall conform to ASTM D-1557 for cohesive soils and ASTM D-2049 for cohesionless soils.

D. Requirements of Regulatory Agencies
1. Proper approval shall be obtained in accordance with applicable City, County and/or State regulations.
2. All safety regulations must be observed including applicable OSHA regulations.

E. Existing Conditions
1. A geotechnical investigation report may be available and included in the project manual for information only.
2. Data in the reports are not intended as representations or warranties of accuracy or continuity of conditions. The Owner or their representative will not be responsible for interpretations or conclusions drawn from this information.

F. Protection
1. Locate existing underground utilities in excavation areas. For aid in utility location call "Dial Dig 1 800 424 5555," 48 hours (two working days) prior to beginning construction. Provide and pay for all marking.
2. If utilities are indicated to remain, support and protect services during excavation operations. Provide temporary utility services where necessary to maintain continuity of service. Provide minimum of seventy-two (72) hour notice to Owner prior to all utility interruptions. Remove existing utilities indicated to be removed. Where uncharted or incorrectly charted utilities are found, contact utility owner immediately for instructions.
3. Protect structures, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations. Damage resulting from excavation operations shall be repaired by the Contractor at their expense.
4. Slope sides of excavation to comply with State and local codes and ordinances. Shore and brace as required for stability of excavation. Maintain shoring and bracing in excavations regardless of duration excavations will be open. Remove shoring and bracing when no longer required.
5. Install sediment and erosion control measures in accordance with State and local codes and ordinances. Protect excavation bottoms against freezing when atmospheric temperature is less than 35 °F.
6. Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area. Do not allow water to

accumulate in excavations. Remove water to prevent softening of bearing materials. Provide and maintain dewatering system components necessary to convey water away from excavations. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey surface water to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches.

7. Stockpile satisfactory excavated materials until required for backfill (place, grade, and shape stockpiles for proper drainage). Locate and retain soil materials away from edge of excavations. Remove and legally dispose of excess excavated materials and materials not suitable for use as backfill. Prevent spillage during hauling operations. In case of spills, clean streets, walks, etc. with power sweepers or as directed by the Owner's Representative.

G. Excavate to uniform width, sufficiently wide to provide ample working room clearance on all sides of pipe, duct, tanks, and equipment. Excavate trenches to depth indicated or required for piping to establish indicated slopes and invert elevations. Where rock is encountered, carry excavation below required elevation and backfill with a minimum 6-inch layer of bedding material between rock bearing surface and pipe. At each pipe joint over-excavate to relieve the bell or pipe joint of pipe loads, and to ensure continuous bearing of pipe barrel on the bearing surface.

H. Minimum trench width shall be the width of the pipe plus 16 inches or the pipe outside diameter times 1.25 plus 12 inches to allow adequate room for joining the pipe, snaking the pipe in the trench to allow for expansion and contraction where appropriate and space for backfilling and compaction of backfill. The space between the pipe and the trench wall shall be wider than the compaction equipment used to compact the backfill.

I. All pipe shall be laid on 6 inch minimum depth of bedding material.

J. Bedding material shall consist of sand. Pipe shall be bedded a minimum of 6" all around the exterior of the pipe with sand bedding. Over excavation shall be sand bedding material as well. Distribute material in maximum layers of 6 inches and thoroughly compact by tamping. Take care to assure compaction under the haunches of the pipe. Fill above the bedding may be find crushed gravel sized no greater than ¾". Pea gravel should not be used for pipe bedding.

K. Bedding, backfill, and excavation for thermoplastic pipe (including PVC) shall additionally comply with the manufacturer's recommendations and with ASTM D-2321 (Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and other Gravity Flow Applications).

L. Where pipes pass under column or wall footings, or within the volume included by extending down from the edge of column or wall footings at a 45 degree angle, and top of pipe is within 2 feet 6 inches below the bottom of the footing, pipes shall be encased in either a steel sleeve or 6 inches of lean (1,500 psi, 28 day test) concrete all around the pipe, extending 5 feet beyond each side of the footing. Where the top of pipe is within 1 foot of the bottom of the footing, lean-concrete encasement, if used, shall extend up to the bottom of the footing.

M. Backfill excavations as promptly as work permits, but not until completion of inspection, testing and approval by authorities having jurisdiction, recording of locations of underground utilities, removal of concrete formwork, removal of shoring and bracing and backfilling of voids, and removal of trash and debris.

N. Backfill material shall be free of cinders, ashes refuse, organic and frozen material, boulders or other unsuitable materials. Suitable material excavated from the trench or other suitable site material not containing rocks in excess of 6 inches in their maximum dimension shall be used for backfill in quantities available. Provide Gravel Borrow in conformance with the Idaho Transportation Departments Construction specifications as needed to complete backfilling operations.

O. Place backfill materials in layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Where layer of soil material must be moisture conditioned before compaction, uniformly apply water. Apply water in minimum quantity necessary to achieve required moisture content and to prevent water appearing on surface during, or subsequent to, compaction operations.

P. Do not place backfill material on surfaces that are muddy, frozen, or contain frost or ice. Place backfill materials evenly adjacent to structures, piping, and equipment to required elevations. Prevent displacement of piping and equipment by carrying material uniformly around them to approximately same elevation in each lift. Compact carefully against foundation, basement and retaining walls so as not to create excessive pressure on walls.

Q. Control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below. Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture-density relationship (cohesive soils), determined in accordance with ASTM D-1557, and not less than the following percentages of relative density, determined in accordance with ASTM D-2049, for soils which will not exhibit a well-defined moisture-density relationship (cohesionless soils).
   1. Areas under Structures, Building Slabs, Steps, Pavement and Walkways: Compact each layer of backfill material to 90 % maximum density of cohesive material, or 95 % relative density for cohesionless material.
   2. Other Areas: Compact each layer of backfill material to 85 % maximum density for cohesive soils, and 90 % relative density for cohesionless soils.
   3. Where subsidence occurs at Division 22 installation excavations during the warranty period, remove surface treatment (i.e., pavement, lawn, or other finish), add backfill material, compact to specified conditions, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent areas.

R. Buried Tanks/Basins:
   1. Bedding material, backfill and methods shall be in accordance with manufacturer’s recommendations.

S. Buried PVC/ABS Sanitary and Storm Sewer Pipe: Excavation, bedding, and backfill for buried PVC/ABS sanitary and storm sewer piping shall be in accordance with ASTM D2321.

3.8 COMMISSIONING SUPPORT

A. The equipment and systems referenced in the Related Work section are to be commissioned per Division 1 and Division 22/23 commissioning specifications. The

contractor has specific responsibilities for scheduling, coordination, startup, testing and documentation. Coordinate all commissioning activities with the Commissioning Authority.

B. Include allowance in the bid to support commissioning.

C. Include time for commissioning activities on the construction schedule to complete commissioning prior to substantial completion with the exception of seasonal testing which the commissioning agent determines should coincide with peak heating and cooling weather conditions.

D. Related Work:
1. Plumbing Mechanical - All Sections in Division 22.

3.9 LOW EMITTING MATERIALS

A. All field applied wet coatings, paints, adhesive and sealants that are installed within the water proofing membrane with Volatile Organic Compounds shall not exceed the limits below.

B. Allowed limits for architectural coatings per South Coast AQMD Rule 1113 effective February 5, 2016 (g/l):

1. Mastic Coatings	100
2. Metallic Pigmented Coatings	150
3. Multi Color Coatings	250
4. Non Flat coatings	50
5. Pre-Treatment Wash Primers	420
6. Primers/Sealants/Undercoats	100
7. Reactive Penetrating Sealers	350
8. Clear Shellac	750
9. Pigmented Shellac	550
10. Specialty Primers	100
11. Water Proofing Sealers	100
12. Other:	Consult Rule 1113.

C. Allowed Limits for sealants per South Coast AQMD Rule 1168 effective October 2017 (g/l):

1. Contact adhesive	350
2. Edge Glue Adhesive	250
3. Plastic ABS Welding Cement	325
4. ABS to PVC transition cement	510
5. CPVC Welding Cement	490
6. PVC Welding Cement	510
7. Other plastic welding cements	250
8. Foam Insulation	250
9. Foam Sealant	250
10. Grout	65
11. Non Staining plumbing putty	150

12. Butyl Tapes	250
13. Fiberglass Duct Liner adhesives	80
14. Other-Duct Sealants	420
15. Other sealants:	Consult Rule 1168.

3.10 CONSTRUCTION IAQ MANAGEMENT DURING CONSTRUCTION

A. All work shall conform with Division 1. Coordinate closely with the general contractor.

B. During Construction meet or exceed the minimum requirements of the SMACNA IAQ Guideline for Occupied Buildings. For new buildings, best management practices shall meet or exceed the requirements of this section.

C. Prepare and submit a written IAQ Management Plan that identifies construction activities that conforms with IAQ best management practices. Submit to the general contractor for review.

D. Acceptable IAQ Management Best Management Practices
1. Summary: Many Best Management Practices are available to maintain IAQ during construction or demolition. The pros, cons, and limitations of each available option should be considered to identify the most effective and most efficient approaches for a particular job. When designing the Plan, the Contractor may use more than one of these practices (simultaneously or phased in) as work progresses. In general, the choices involve:
   a. Containing the work area.
   b. Modifying operation.
   c. Reducing emissions.
   d. Intensifying housekeeping.
   e. Rescheduling work hours or moving occupants.
2. Hazardous wastes shall be separated, stored, and disposed of according to local regulations.
3. Storage and Protection: Designate receiving/storage areas for incoming material to be delivered according to installation schedule and to be placed convenient to work area in order to minimize waste due to excessive materials handling and misapplication. Protect stored on-site or installed absorptive materials from moisture damage.
4. Modifying Equipment Operation: Use of equipment may need to be restricted in order to meet IAQ objectives. This could involve substituting cleaner equipment or simply changing operating Procedures. Examples of such controls include:
   a. Restricting traffic volume or prohibiting idling of motor vehicles where emissions could be drawn into occupied areas.
   b. Switching from diesel to bottled gas for equipment such as generators or fork lifts (emissions are cleaner but still potentially harmful under some circumstances). Use of electric fork lifts and other equipment should be considered when feasible, since they do not burn fossil fuels, thus eliminating exposure to combustion gas emissions.
5. Changing Work Practices: For some demolition tasks (e.g., paint stripping) there may be techniques available that produce less airborne dust. Some painting techniques release fewer odors. Some cleaning practices raise less dust.
6. Local Exhaust: Pollution sources can be directly exhausted to the outside. This may be done through an exhaust system already available in the building or more often

by a portable fan vented to the outside and attached to the work site by flex duct. Depending on the nature of the material and the location of the exhaust, special filtration of the exhaust may or may not be necessary. Any emissions to the outside must be in compliance with applicable regulations and should be directed well away from intakes.

7. Air Cleaning: Where exhaust is not feasible, local re-circulation of air through a portable air cleaner may be effective. The type of filter should be suitable for the material being controlled (e.g., charcoal or potassium permanganate for many odors, a moderate to high efficiency filter for dust).
8. Cover or Seal: VOC emissions are a result of evaporation from an exposed surface. Reducing the exposed surface reduces emissions. For example:
   a. An enclosed tanker is preferable to an open kettle for roofing.
   b. Containers of wet products should be kept closed as much as possible.
   c. Waste materials that can release odor or dust should be covered or sealed.
   d. Applying a sealer may control a surface that is a persistent odor source.

3.11 CONSTRUCTION WASTE MANAGEMENT

A. As part of the sustainable construction process, construction waste may be salvaged or re-used. This is a collaborative effort and should be coordinated with the General Contractor who is responsible for administration of the construction waste management plan.

3.12 PROJECT CLOSEOUT/OPERATION AND MAINTENANCE MANUAL

A. Electronic submittals shall be provided with accordance with all of the following conditions. Electronic submittals which do not comply with all of these conditions will be rejected without review.
   1. Electronic submittals shall be submitted in the current version of Adobe Portable Document Format (PDF)
   2. Submittals shall be original PDF’s of the document and shall not be created using scanned copies of paper documents.
   3. PDF documents shall be searchable.
   4. PDF documents shall be unlocked
   5. Electronic submittals shall be separated by specification section and identified as such. Submittals which combine multiple sections into a single document will be rejected.
   6. Electronic submittals shall include a table of contents and each applicable section shall be bookmarked for easy access.
   7. Electronic submittals shall be clearly marked in RED using boxes and arrows and other appropriate markings to indicate specific product information, option selections, accessories, etc.
   8. Each product shall be keyed to the paragraph number in the specifications.

B. Cover page shall include:
   1. Job title
   2. Date
   3. Engineer
   4. Architect
   5. Contractor

6. Construction Division

C. Manual shall be organized into the following five sections:
   1. Contacts: This shall consist of name, address, and phone number of the following parties: Architect, Mechanical Engineer, Electrical Engineer, General Contractor, HVAC Contractor, Plumbing Contractor, Sheet Metal Contractor, Temperature Controls Contractor, Sprinkler Contractor, Electrical Contractor and major equipment suppliers.
   2. Equipment
      a. Begin the Equipment section with a separate sub-section containing a list of the Division 22 equipment indicating:
         1) Equipment name and designation as it appears on the equipment schedule
         2) Area served
         3) Manufacturer
         4) Model
         5) Serial number
         6) Name plate data
      b. The remaining sub-sections shall include, at a minimum, the following for each item of Division 22 equipment. This material shall be organized in a separate tabbed sub-section for each section of the specifications. Within each sub-section, provide separate tabs for each item of equipment, referencing the equipment schedule designation. Provide the following information as applicable:
         1) Performance curves or tables showing the specified operating points and the operating points after final testing and balancing
         2) Manufacturer's maintenance instructions: Instructions shall include name of vendor, installation instructions, parts numbers and lists, operation instructions of equipment, maintenance and lubrication instructions, troubleshooting guides, and overhaul specifications for major equipment.
         3) Step-by-step procedure to follow in putting each piece of Division 22 equipment into operation
         4) Wiring diagram for particular equipment item
      c. Refer to individual specification sections for additional information required to be incorporated into the Operation and Maintenance Manual.
   3. Maintenance Schedule and Spare Parts
      a. This shall include two sub-sections:
         1) The first sub-section shall consist of a preventative maintenance schedule summary table (or list). The table shall be organized by specification section and include:
            a) Equipment name and designation as it appears on the equipment schedule
            b) Equipment location
            c) Type and frequency of preventative maintenance requirements (including lubrication)
         2) The second sub-section shall consist of a list of spare parts furnished under this contract. The list shall be organized by specification section and include (similar to that included at the end of this section):
            a) Equipment name and designation as it appears on the equipment schedule
            b) Spare part furnished

c) Verification by an Owner's Representative that the part(s) have been provided

4. Warranties and Certifications
   a. Shall include:
      1) Test and balance reports
      2) Test records of piping, tanks, etc
      3) Signed checklist of instruction period
      4) Certificate from Health Department indicating acceptance of domestic water quality
      5) Copies of specific product warranties
      6) Copies of certified factory start-up reports
      7) Valve tag identification schedules
      8) Copy of manual describing specific maintenance services that will be furnished under this contract

D. Prepare two (2) printed copies in three ring binders of approved manuals for use during the instruction period. Following instruction period, turn over both copies to the Owner's representative and the Owner.

E. Manuals may be compiled in multiple volumes if necessary for ease of use.

3.13 PROJECT CLOSEOUT/CERTIFIED FACTORY START-UP

A. Refer to individual sections of these Specifications for specific requirements of certified factory start-up.

B. Start-up shall be performed by a certified factory representative. Prior to start-up, certification of factory representative shall be forwarded to the Engineer for review.

C. Start-up shall be scheduled with the owner to allow witnessing of start-up procedures by maintenance personnel. Operation and maintenance training for equipment requiring certified factory start-up shall be conducted at the time of start-up with the certified factory representative present.

D. Certified factory start-up is required for the following equipment:
   1. Water Heaters
   2. Air Compressors

3.14 PROJECT CLOSEOUT/OPERATION AND MAINTENANCE TRAINING

A. General
   1. Two (2) training sessions shall be scheduled. The first shall occur after final inspection and prior to substantial completion. The second shall occur prior to the end of the first year of operation after acceptance. Training sessions shall be scheduled with the owner a minimum of two (2) weeks in advance.
   2. Instruct the Owner's representative(s) in operation and maintenance of Division 22 systems utilizing Operation and Maintenance Manual.
   3. Individuals present shall include the plumbing contractor, subcontractors and equipment factory representatives as appropriate. Certified factory representatives shall be present for all equipment requiring certified factory start-up.

4. The contractor's representative performing the operation and maintenance training shall locate in the building each piece of equipment included in the O&M manuals, and shall instruct to the satisfaction of the owner's representative required operation and maintenance procedures as outlined in the O&M manuals.
5. Provide a digital video of the training sessions conducted and furnish copies of the video to the Owner. Digital videos shall be of sufficient quality to allow training of future employees or refresher training of personnel. Use DVD format unless directed otherwise by the owner.
6. Training shall occur after final inspection and prior to acceptance by owner. It shall be scheduled with the owner, and shall occur in one consolidated session for all Division 22 equipment.
    a. Exceptions:
        1) Training for equipment requiring certified factory start-up shall be conducted at the time of start-up.
        2) Multiple sessions shall be scheduled as required to maintain a maximum allowable duration of any single session of four (4) hours.
        3) When separate training sessions are warranted to achieve proper training on all equipment and systems, as determined by the owner's representative, multiple sessions shall be scheduled as required.
        4) Training session shall include all equipment included in the table at the end of this section. A table similar to this one shall be used to verify owner training has been completed on all equipment, and shall be included in the Operation and Maintenance Manual.
7. A second training session shall occur prior to the end of the first year of operation after acceptance. Prior to this session, the owner shall submit a list of items to be covered. This session shall include all parts of the first training session necessary to meet the satisfaction of the owner, up to and including full training of all equipment and systems.

3.15 PROJECT CLOSEOUT/SPARE PARTS/MAINTENANCE MATERIALS

A. A list of spare parts to be provided under this contract has been included at the end of this section. Refer to individual specification sections for specific requirements of spare parts to be furnished under this contract.

B. Turn spare parts and materials over to Owner.

C. Provide summarized list of spare parts that have been furnished. List shall include verification by owner's representative that parts have been furnished. Incorporate into O&M Manual. Spare parts list shall be similar to that provided at the end of this section.

3.16 PROJECT CLOSEOUT/96-HOUR RUN TEST

A. Refer to Section 23 05 00.

3.17 PROJECT CLOSEOUT/PRE-BALANCE REQUIREMENTS

A. Assist test and balance agency, complete pre-balance checklists and attend pre-balance conference in accordance with Section 23 05 00.

3.18 PROJECT CLOSEOUT/WARRANTIES

A. Provide specific equipment/material warranties that extend beyond 1 year project warranty period.
   1. Refer to individual specifications sections for required extended warranties.
   2. Incorporate extended warranties into O&M Manual in warranties section.

3.19 PROJECT CLOSEOUT/FINAL CLEANING

A. Clean up all equipment, materials, cartons and other debris that is a direct result of the installation of equipment under this contract.

B. Clean exposed piping, equipment, and fixtures. Repair damaged finishes and leave everything in working order.

C. Remove stickers from fixtures and adjust flush valves.

3.20 PROJECT CLOSEOUT/RECORD DRAWINGS

A. Provide in accordance with Division 01 and the requirements of this section.

B. Record differences between mechanical work as installed and as shown in Contract Documents on a set of prints of mechanical drawings to be furnished by Owner's Representative. Return these prints to the Owner's Representative at completion of Project Notations made on drawings shall be neat and legible. These drawings shall not be used for any other purposes.
   1. Coordination drawings and fabrication drawings may not be utilized as record drawings unless:
      a. Content from original drawings set such as notes and keynotes are transferred over to the coordination and fabrication drawings.
      b. Drawings shall not be multidiscipline (ie plumbing and HVAC on same sheet) unless prepared that way in the construction documents.
      c. Drawings clearly identify deviations/modifications to the construction documents.

C. Refer to individual specification sections for additional requirements.

3.21 PROJECT CLOSEOUT/PUNCH LIST PROCEDURES

A. The Contractor shall notify the Owner's Representative in writing when the project is ready for punch lists. The following items must be complete before punch list will be performed, and must be provided with written verification:
   1. Systems are complete and functional, including controls and control interface with Section 23 09 23 control systems when specified or indicated on drawings.
   2. Testing and balancing is complete, and test and balance reports have been submitted for review.
   3. Operation and Maintenance Manuals are complete, and have been submitted for review.

B. After punch lists are complete, written notice must be forwarded to the Owner's Representative requesting final checkout. Any additional trips beyond the final checkout required due to incomplete items on previous punch lists will be billed to the Contractor at normal rate plus travel expenses.

C. At the time of initial and final observation, the project foreman shall accompany the observation party and shall remove access panels and perform other duties, as required, to allow complete observation of the entire Division 22 system.

3.22 PROJECT CLOSEOUT/MAINTENANCE SERVICES

A. Provide a separate manual describing specific maintenance services to be provided under this contract as required under specific specification sections.

PART 4 - TABLES

4.1 COST BREAKDOWN

A. Provide breakdown for the categories that follow. Each category shall identify separate costs for material and labor/installation.

B. Category:
1. Mobilization
2. Supervision
3. Site Utilities
4. Underfloor Plumbing
5. Plumbing Rough-in
6. Plumbing Equipment (floor drains, roof drains, pumps, water hammer arrestors, valves, hot water tanks, separators, etc)
7. Plumbing Fixtures
8. Plumbing Insulation
9. Compressed Air System
10. Commissioning Assistance

4.2 SPARE PARTS LIST

A. For each item obtain signature from person receiving spare parts and date this transfer occurred.

B. Section 22 05 04, Frost Proof Wall Hydrants
1. Two (2) loose keys

C. Section 22 05 19, Gauges
1. Test kit

D. Section 22 40 00, Faucets
1. Two (2) sets of faucet washers for each different washer type

E. Section 22 40 00, Flush Valves
   1. Flush valve service kits

F. Section 22 40 00, Faucets
   1. Two (2) of each different cartridge

END OF SECTION

SECTION 22 05 04

PLUMBING SPECIALTIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Backflow preventers

B. Cleanouts

C. Downspout nozzles

D. Floor drains

E. Frost Proof Wall and Roof Hydrants

F. Interior hose bibs

G. Mixing valves

H. Oil/Water Separator

I. Roof and overflow drains

J. Trap primers

K. Trench drains

L. Water hammer arrestors

1.2 RELATED SECTIONS

A. Section 22 05 00 – Common Work Results for Plumbing

B. Section 22 05 17 – Sleeves and Sleeve Seals for Plumbing Piping

C. Section 22 05 23 – General Duty Valves for Plumbing Piping

D. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment

E. Section 22 07 00 – Plumbing Insulation

F. Section 22 10 00 – Plumbing Piping

G. Section 22 30 00 – Plumbing Equipment

H. Section 22 40 00 – Plumbing Fixtures

1.3 REFERENCES

A. General:
   1. ASSE 1011 - Hose Connection Vacuum Breakers

B. Backflow preventers:
   1. ASSE 1012 - Backflow Preventers with Immediate Atmospheric Vent
   2. ASSE 1013 - Backflow Preventers, Reduced Pressure Principle

C. Floor drains:
   1. ASME A112.21.1 - Floor Drains

D. Frost Proof Wall Hydrants:
   1. ASSE 1019 - Wall Hydrants, Frost Proof Automatic Draining Anti-Backflow Types

E. Roof and overflow drains:
   1. ASME A112.21.2 - Roof Drains

F. Water hammer arrestors:
   1. ASME A112.26.1 - Water Hammer Arrestors
   2. PDI WH-201 - Water Hammer Arrestors

1.4 SUBMITTALS FOR REVIEW (REFER TO SECTION 22 05 00)

A. Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.

B. Shop Drawings: Indicate dimensions, weights, and placement of openings and holes.

1.5 OPERATION AND MAINTENANCE DATA (REFER TO SECTION 22 05 00)

A. Operation Data: Indicate frequency of treatment required for interceptors.

B. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.6 PROJECT RECORD DOCUMENTS (REFER TO SECTION 22 05 00)

A. Record actual locations of cleanouts and equipment.

1.7 DELIVERY, STORAGE, AND HANDLING (REFER TO SECTION 22 05 00)

A. Accept specialties on site in original factory packaging. Inspect for damage.

1.8 REGULATORY REQUIREMENTS

A. All piping, fittings, valves, fixtures, faucets and equipment containing or conveying potable water shall comply with the latest US Safe Drinking Water Act mandating any

wetted surface of the above mentioned items shall not contain above 0.25% lead content by weighted average. All piping, fittings, valve and equipment containing or conveying potable water shall comply with NSF 61 G and NSF 372 or shall be provided with indication on submittals the manufacturer's declaration of self-certification.

1.9 EXTRA MATERIALS (REFER TO SECTION 22 05 00)

A. Frost Proof Wall Hydrants
   1. Supply two loose keys for outside hose bibbs.

PART 2 - PRODUCTS

2.1 BACKFLOW PREVENTERS

A. Manufacturers (Refer to Section 22 05 00):
   1. Watts
   2. Wilkins

B. Reduced Pressure Backflow Preventers: ANSI/ASSE 1013; AWWA C506; bronze body with bronze internal parts and stainless steel springs; two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; third check valve that opens under back pressure in case of diaphragm failure; non-threaded vent outlet; assembled with two gate valves, strainer, and four test cocks.

C. See schedule on drawings for additional types of Backflow prevention devices.

2.2 CLEANOUTS

A. Manufacturers (Refer to Section 22 05 00):
   1. J.R. Smith
   2. Zurn
   3. Wade
   4. Sioux Chief
   5. Mifab

B. General: Cleanouts shall be heavy iron bodies with taper thread-bronze plugs. ASME A112.21.1m. They shall be full size of the pipe to 4 inches and not less than 4 inches for larger pipe. Cleanout extensions shall have flush frames and brass removable cover plates. Extensions to floor shall be made by using 1/8 bends.

C. Floor Cleanouts: Coated cast iron body; scoriated heavy duty nickel bronze top; fully adjustable and secured to body; gasket sealed iron closure plug; Cleanouts in tiled terrazzo or similar paved floors: J.R. Smith #4180; Cleanouts installed in ceramic tile floors: J.R. Smith #4040; Cleanouts installed in floors with asphalt, vinyl or linoleum: J.R. Smith #4140.
   1. Cleanouts in other finished areas shall have round tops.
   2. Cleanouts installed above grade shall have flange and flashing clamp.

3. Cleanouts in carpeted areas shall be furnished with carpet marker: J.R. Smith #4160.
4. Cleanouts in unfinished areas shall have heavy duty cast iron covers.
5. All cleanouts shall have vandal-proof screws.

D. Wall Cleanouts: Coated cast iron cleanout tee; gasket sealed iron plug; shallow type; round, stainless steel wall cover with center vandal-proof screw.

E. Exposed Cleanouts: Lead seal plug with gasketed iron plug or tapped cast iron fitting with gasketed iron plug.

F. Exterior Cleanouts: Cleanouts in sewers outside building proper shall be of 4 inch cast iron pipe brought up to finish grade with cast iron cap recessed ¼ inch in 18×18×6 inch concrete block. Block shall have beveled edge and shall be set flush with top of finish grade. Cleanout shall be equal to J.R. Smith #4255.

G. All exposed cleanouts shall be vandal proof.

2.3 DOWNSPOUT NOZZLES

A. Manufacturers (Refer to Section 22 05 00):
1. J.R. Smith
2. Zurn
3. Wade
4. Sioux Chief
5. Mifab

B. Bronze round with straight bottom section unless scheduled otherwise on drawings.

2.4 FLOOR DRAINS

A. Manufacturers (Refer to Section 22 05 00):
1. J.R. Smith
2. Zurn
3. Wade
4. Sioux Chief
5. Mifab

B. ANSI A112.21.1; lacquered cast iron two piece body with double drainage flange; weep holes; reversible clamping collar; refer to schedule on drawings for accessories.

C. All floor drains shall be vandal proof.

2.5 FROST PROOF WALL HYDRANTS

A. Manufacturers (Refer to Section 22 05 00):
1. J.R. Smith
2. Zurn
3. Wade
4. Mifab

B. ANSI/ASSE 1019; non-freeze; self-draining type with wall plate lockable recessed box; hose thread spout; T-handles removable key; and integral vacuum breaker. Nickel bronze finish unless scheduled otherwise on drawings.

2.6 FROST PROOF ROOF HYDRANTS

A. Manufacturers (Refer to Section 22 05 00):
1. J.R. Smith
2. Zurn
3. Wade
4. Mifab

B. Self draining, non-freeze,roof hydrant with 3/4” male hose connection with heavy duty cast iron head casting and lift handle with lock feature and combination 3/4” female and 1” male inlet connection. Hydrant assembly complete with one piece neoprene plunger, hardened bronze operating stem, 1” galvanized steel casing, heavy duty bronze head casting with head nut assembly, 3/8” diameter galvanized steel operating rod and a tapped 1/8” drain port in the bronze tailpiece.

2.7 SAND/OIL SEPARATOR

A. Manufacturers (Refer to Section 22 05 00):
1. Striem
2. Canplas

B. Hydromechanical type with flow control fittings for oil water separator use and designed for H-20 wheel loading. Interceptor shall be made of seamless, rotationally-molded polyethylene. Interceptor shall be made for below grade installation. Provided with field cut riser systems, built-in flow control (when required), built-in test caps, and control panel.

C. Provided with engineered inlet and outlet diffusers to promote laminar flow and increased oil water separation.

D. Certifications: Listed by IAPMO to ASME A112.14.3. Compliant with Uniform Plumbing Code and International Plumbing Code.

E. Maximum operating temperature 140° F continuous.

F. High Water Table Hold Down Kit when required by site conditions.

G. Provide oil level monitoring system with interface float and a NEMA 4x fiberglass weatherproof enclosure and a dry contact for connection to the building alarm system. Interface float wiring shall be run through ½” PVC pipe into the bottom of the junction box inside the adapter.

H. Manhole ring and covers
1. Nominal 24 inch round; heavy duty; (H-20 wheel load) cast iron frame and solid gas-tight covers
2. Provide manholes for each compartment and at cleanout locations

3. Bolted pickable cast iron covers

I. Installation
1. Below grade with lid mounted to tank and level with slab
2. Fully buried with manhole at slab or grade indicated on plans

J. Accessories
1. Field cut riser
2. Membrane clamping collar
3. Integral anti—siphon air relief
4. Integral anti—siphon air reliefOil level monitoring system

K. See drawings for size and detail. Interceptors shall be capable of solids (sand and dirt) storage and oil retention in the volumes scheduled on the drawings.

2.8 INTERIOR HOSE BIBBS

A. Manufacturers (Refer to Section 22 05 00):
1. J.R. Smith
2. Zurn
3. Wade
4. Woodford
5. Mifab

B. All brass construction with lock-shield, loose key, or wheel handle (see schedule on drawings) and stuffing box and replaceable disc. Hose bibbs shall have ¾ inch inlet and ¾ inch hose connection and shall be fitted with a non-removable vacuum breaker in conformance with ANSI/ASSE 1011.

C. Hose bibbs in finished areas shall be smooth, chrome plated with finish flanges.

D. Hose bibbs in unfinished areas shall be rough brass finished.

2.9 POINT OF USE MIXING VALVES

A. Manufacturers (Refer to Section 22 05 00):
1. Acorn
2. Symmons
3. Leonard
4. Bradley

B. Valve Assembly: All bronze and stainless steel components; Thermostatic action with bellows mounted out-of-water; Removable cartridge with strainers; Integral check stops; outlet valve and dial thermometer; All material rough chrome finish; Assembly to be furnished with wall bracket for exposed installation; See schedule on drawings. Point of use mixing valve shall be used for wash fountains only (WF-1).

2.10 MASTER MIXING VALVE

A. Manufacturers (Refer to Section 22 05 00):
   1. Acorn
   2. Symmons
   3. Leonard

B. Provide as scheduled on the drawings.

2.11 ROOF AND OVERFLOW DRAINS

A. Manufacturers (Refer to Section 22 05 00):
   1. J.R. Smith
   2. Zurn
   3. Wade
   4. Sioux Chief
   5. Mifab

B. Roof and Overflow Drains: ANSI A112.21.2; lacquered cast iron body with sump; metal dome strainer; membrane flange and membrane clamp with integral gravel stop; adjustable under deck clamp; roof sump receiver; coordinate with roofing type; refer to schedule on drawings. Overflow drains shall have 2 inch high dam.

2.12 TRAP PRIMERS (MECHANICAL)

A. Flush valve adapter trap primer assembly: Vacuum breaker trap primer, chrome plated tubing; compression fittings and escutcheons. For use on flush valves operating between 1.28 and 3.5 gallons per flush
   1. Manufacturers (refer to section 22 05 00)
      a. Sloan F-VBF-72 series to suit flushometer type

B. Trap primer tailpiece (gravity fed with ½" nominal branch connection)
   1. Manufacturers (refer to section 22 05 00)
      a. Sioux Chief
      b. Mifab

C. Pressure drop activated trap seal primer assembly with at least 3 psig minimum line pressure drop at a minimum flow rate of 0.5 gpm.
   1. Manufacturers (refer to section 22 05 00)
      a. PPP Inc.
      b. Mifab

2.13 TRENCH DRAINS

A. Manufacturers (Refer to Section 22 05 00):
   1. Jay R. Smith
   2. Poly Drain
   3. Zurn
   4. Mifab

B. The trench drains shall be channels with interlocking joints and horizontal ribs to ensure a positive anchor in the encasement concrete. Properly fitting outlets, end caps and necessary catch basins shall be included. See schedule on drawings.

C. The grate shall be capable of being locked to the channel with removable lock downs.

2.14 WATER HAMMER ARRESTORS

A. Manufacturers (Refer to Section 22 05 00):
1. Sioux Chief 650 series
2. Zurn 1260XL
3. PPP SC Series
4. Jay R. Smith 520
5. Mifab CL or CLS Series

B. ANSI 1010; copper construction; piston type; suitable for operation in temperatures up to 200 °F and maximum 200 psi working pressure. Units shall bear PDI seal of approval.

PART 3 - EXECUTION

3.1 INSTALLATION – GENERAL

A. Provide specialties in accordance with manufacturer's instructions and as indicated on the drawings.

B. Provide access doors where specialties are not exposed unless indicated to be provided under other Divisions. Access doors shall comply with Division 8. Coordinate sized location with access requirements.

3.2 BACKFLOW PREVENTERS

A. Install approved potable water protection devices where indicated and on plumbing lines where contamination of domestic water may occur; on boiler feed water lines, janitor rooms, fire sprinkler systems, premise isolation, irrigation systems, flush valves, interior and exterior hose bibs.

B. Pipe relief from backflow preventer to nearest drain.

3.3 CLEANOUTS

A. Provide cleanouts in accordance with the Uniform Plumbing Code where indicated on the drawings (whether indicated or not) and as specified herein.

B. A cleanout fitting shall be installed at the end of each horizontal drainage line that changes direction to vertical.

C. An additional cleanout shall be provided in a drainage line for each aggregate horizontal change of direction exceeding 135 degrees.

D. Cleanouts in buildings shall be not more than 100 feet apart in horizontal drainage lines.

E. A cleanout fitting shall be installed in any drainage pipe upstream of the most remote upper terminal (sink, roof drain, floor drain etc) and upstream of any terminal located more than 5 feet from the main service pipe.

F. An easily accessible cleanout shall be provided at or near the floor in each vertical waste and soil stack, and at each urinal. Each house sewer shall be provided with a cleanout within 7 feet of where sewer leaves the building, installed in a “Y” branch fitting; additional cleanouts shall be installed where indicated on drawings and as required by code

G. A cleanout fitting in the wall shall be provided for all urinals in an accessible location.

H. A cleanout fitting in the wall shall be provided for all sinks (with domestic/potable and non-potable water) and lavatories. Cleanout shall be located in an accessible location under the sink (flush with wall or casework).

I. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.

J. Encase exterior cleanouts in 18×18×6 inch concrete flush with grade. Block shall have beveled edge.

K. Install floor cleanouts at elevation to accommodate finished floor.

3.4 TRAP PRIMERS

A. Provide trap primers at all traps in the sanitary waste system whether indicated on the drawings or not. Exception: trap primers may be omitted where water is continuously wasted by item of equipment. Install in accordance with manufacturer requirements.

B. Application: Wherever possible, trap primer tailpiece assemblies or flush valve adaptor type shall be used in lieu of other primer types
   1. Provide trap primer tailpiece or flush valve adaptor type for floor drains located near flush fixtures.
   2. Water flow sensing type may be utilized in ½” diameter cold water pipes serving frequently used fixtures that do not have mixing valves.
   3. In mechanical rooms or remote areas pressure activated trap primer devices shall be used.

C. Trap primer water source shall be from a cold-water pipe.

D. Slope trap primer piping from trap primer to drain in direction of flow.

E. Where primer is located in finished area, conceal it in wall and provide an access panel.

F. Pipe connection between primer and drain shall be made with 3/8 inch ID piping. Exposed primer tubing shall be chrome plated. Provide piping in accordance with Section 22 10 00.

3.5 TRENCH DRAINS

A. The trench drains shall be installed in strict accordance with manufacturer's instructions and details. Installation chairs shall be used where sub-base allows, to hold the channels to line and grade, prevent floatation and ensure proper concrete encasement. Coordinate with structural and architectural installation requirement.

3.6 WATER HAMMER ARRESTORS

A. Water hammer arrestors shall be sized and installed in accordance with the manufacturer's instructions and recommendations and in accordance with the following schedule. Install water hammer arrestors at all quick closing valves, spray wands, and solenoid valves and at each individual plumbing fixture or battery of fixtures (except drinking fountains) in domestic water systems. Air chambers are not allowed.

Size (inches)	**Fixture Units**	**Cross Reference PDI Standard**
¾	1 to 11	A
1	12 to 32	B
1	33 to 60	C
1	61 to 113	D
1	114 to 154	E
1	155 to 330	F

END OF SECTION

SECTION 22 05 13

COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Common requirements for electric motors furnished on equipment specified in other Sections, including single phase and three phase electric motors.

1.2 RELATED SECTIONS

A. All mechanical sections with motor driven equipment

B. Section 22 05 00 – Common Work Results for Plumbing

1.3 REFERENCES

A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings

B. NEMA MG 1 - Motors and Generators

C. NFPA 70 - National Electrical Code

1.4 REGULATORY REQUIREMENTS

A. Conform to UL Component Recognition for appropriate sizes

B. Conform to NFPA 70 and applicable State energy code

1.5 DELIVERY, STORAGE, AND HANDLING (REFER TO SECTION 22 05 00)

A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

PART 2 - PRODUCTS

2.1 MANUFACTURERS (REFER TO SECTION 22 05 00):

A. Century

B. Baldor

C. Marathon

D. General Electric

E. Westinghouse

2.2 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Motors less than 250 Watts, for intermittent service: Equipment manufacturer's standard and need not conform to these specifications.

B. Electrical Service:
   1. Unless indicated otherwise on equipment schedules, motors shall be supplied as with the following electrical characteristics:
      a. Motors ½ horsepower and smaller: 115 single phase, 60 Hz
      b. Motors larger than ½ horsepower shall be three phase and shall be rated as specified and scheduled

C. Design for continuous operation in 104°F environment.

D. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.

E. Visible Nameplate: Indicating manufacturer's name and model number, motor horsepower, RPM, frame size, voltage, phase, cycles, full load amps, insulation system class, service factor, maximum ambient temperature, temperature rise at rated horsepower, minimum efficiency.

F. Nominal Efficiency: All motors shall be NEMA "premium efficiency" type. Motors shall also meet or exceed required efficiency of the State energy code.

G. Wiring Terminations:
   1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
   2. For fractional horsepower motors where connection is made directly, provide conduit connection in end frame.

2.3 SINGLE PHASE POWER - CAPACITOR START MOTORS

A. Starting Torque: Three times full load torque

B. Starting Current: Less than five times full load current

C. Pull-up Torque: Up to 350 % of full load torque

D. Breakdown Torque: Approximately 250 % of full load torque

E. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.

F. Drip-proof and Enclosed Motor Enclosures: Class F insulation, rated for 311 °F maximum temperature, NEMA Service Factor, prelubricated sleeve or ball bearings.

2.4 THREE PHASE POWER - SQUIRREL-CAGE MOTORS

A. Starting Torque: Between 1 and 1½ times full load torque

B. Starting Current: Six times full load current

C. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics

D. Design, Construction, Testing, and Performance: Conform to NEMA MG 1 for Design B motors

E. Insulation System: NEMA Class F or better

F. NEMA Service Factor

G. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.

H. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum AFBMA 9, L-10 life of 200,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

I. Sound Power Levels: To NEMA MG 1

2.5 ENCLOSED MOTOR CONTROLLERS (MOTOR STARTERS)

A. Enclosed Motor Controllers (starters) and switches are not under Mechanical unless specifically specified with a particular mechanical equipment item.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.

B. Check line voltage and phase and ensure agreement with nameplate.

C. Motor starters and disconnects are not installed or furnished under Mechanical unless specified or scheduled to be factory furnished and mounted with a particular mechanical

equipment item. Starters which are furnished with a particular mechanical equipment item but are shipped loose are not installed or wired under Mechanical.

D. Application
1. Open drip-proof enclosures (ODP) except where specifically noted otherwise.
2. Single phase motors:
   a. Capacitor start type
3. Three phase motors:
   a. Squirrel-cage type

E. NEMA Open Motor Service Factor Schedule

HP	1800 RPM Motor
1/6 to 1/3	1.35
½ to ¾	1.25
1 to 150	1.15

END OF SECTION

SECTION 22 05 16

EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Manufactured Pipe Expansion Loops

1.2 RELATED SECTIONS

A. Section 22 05 00 – Common Work Results for Plumbing

B. Section 22 05 23 – General Duty Valves for Plumbing Piping

C. Section 22 07 00 – Plumbing Insulation

D. Section 22 10 00 – Plumbing Piping

E. Section 22 15 00 – General Service Compressed Air Systems

F. Section 22 30 00 – Plumbing Equipment

1.3 SUBMITTALS FOR REVIEW (REFER TO SECTION 22 05 00)

A. General: Component construction materials and methods; dimensions.

B. Manufactured Pipe Expansion Loops: Rigid and flexible pipe materials and construction; configuration; temperature and pressure rating of equipment; performance characteristics including expansion and contraction capabilities, manufacturer's special required procedures and external controls.

1.4 OPERATION AND MAINTENANCE MATERIALS (REFER TO SECTION 22 05 00)

A. General: Include equipment adjustment instructions.

1.5 DELIVERY, STORAGE, AND HANDLING (REFER TO SECTION 22 05 00)

A. Protect equipment from exposure by leaving factory coverings, pipe end protection, and packaging in place until installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERED PIPE EXPANSION LOOPS

A. Manufacturers (Refer to Section 22 05 00):
   1. Twin City Hose
   2. Mason
   3. Metraflex Metraloop

B. Basis of Design for potable water systems: UPC Listed Copper Metraloop

C. Basis of Design for gas systems: AGA/CSA Gas Metraloop

D. Construction: Pipe materials of construction and fitting type shall be consistent with pipe material and equipment/pipe connection fittings. Rigid pipe and connections shall meet the requirements of the piping system in which the expansion loop is being installed; stainless steel inner hose and double-braided outer sleeve flexible pipe for steel piping systems; bronze inner hose and braided bronze outer sleeve flexible pipe for copper piping systems; 150 psig design pressure; 225 psig test pressure; 850 °F maximum working temperature.

E. Flexible loops shall impart no thrust loads to system support anchors or structure.

F. Configuration: Two flexible pipe sections connected with a 180° bend at one end and provided with a 90° elbow at the other end of each of the flexible pipe sections. Exceptions:
   1. Configuration shall be different when required by the specific installation (i.e. when installed at a 90° bend in the piping system, which would require 135° bends in lieu of 90° bends).
   2. Nested configurations may be utilized in parallel pipe runs to keep all expansion/seismic devices in one location. Nested configurations require (2) 90° bends with straight pipe in a loop fashion in lieu of the 180° bend.

G. Provide with drain/air release plug on 180° bend.

H. Factory supplied center support nut.

I. Certifications for Loops:
   1. Gas expansion loop shall be CSA/AGA certified.
   2. For potable water systems, connectors and construction shall be UL classified in accordance with ANSI/NSF 61-1977 standards.

J. Install in accordance with the manufacturers' written instructions.

K. When spanning a building seismic expansion joint, guides and anchors are not required.

L. Install in a neutral, pre-compressed or pre-extended condition as required for the application.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide in accordance with manufacturer's instructions.

3.2 PIPE EXPANSION LOOPS

A. Provide at each pipe penetration of the building seismic/expansion joint.

B. Loops pipe diameter shall be same as connecting pipe.

C. Install in a neutral, pre-compressed or pre-extended condition as required for the application.

D. Rigidly support pipe on either size of loop on each side of the seismic joint in accordance with the manufacturer's requirements.

E. Prior to preparation of submittals and ordering, contractor shall coordinate available space and provide over/under loops, nested loops, vertical or horizontal loops as required to fit within available space. Submittals shall indicate configuration.

END OF SECTION

SECTION 22 05 17

SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Flashing

B. Sleeves

1.2 RELATED SECTIONS

A. Division 7 - Thermal and Moisture Protection

B. Section 22 05 00 - Common Work Results for Plumbing

C. Section 22 05 23 – General Duty Valves for Plumbing Piping

D. Section 22 05 48 – Vibration Isolation

E. Section 22 07 00 – Plumbing Insulation

F. Section 22 10 00 – Plumbing Piping

G. Section 22 15 00 – General Service Compressed Air Systems

H. Section 22 30 00 – Plumbing Equipment

1.3 SUBMITTALS FOR REVIEW (REFER TO SECTION 22 05 00)

A. Product Data: Provide manufacturers catalog data.

B. Manufacturer's Installation Instructions: Indicate special procedures and assembly of components.

PART 2 - PRODUCTS

2.1 FLASHING

A. Roof Flashing
1. Flashing materials shall be coordinated and approved by the roof manufacturer system and not alter the roof warranty.
2. Products may include:

a. Oatey Master Flash: EPDM and compounded for maximum resistance for weathering due to ozone or UV light. Pliable and accommodates vibration, pipe movement caused by expansion and contraction and snow-load movement. Continuous temperature resistance of 212 degrees F. Suitable for any roof pitch Not for use on hot mopped or built-up roofs.
b. Oatey All Flash No-Calk Roof Flashings: Thermoplastic, aluminum (0.032”), or galvanized base flashings (24 gauge).
c. FlashCo L-Series lead flashing for round roof penetrations with counterflashing for vent pipes.
d. Accessories:
   1) Stainless steel hose clamp
   2) Caulking for non-vent applications
   3) Bonnets or collars with material matching flashing

B. Other Flashing
1. Flexible Flashing: 47 mil galvanized steel shell and base, rigid insulation, mitered 3 inch cant, wood nailer, with variable step to match roof insulation and gravel
2. Metal Flashing: 26 gauge galvanized steel
3. Metal Counterflashing: 22 gauge thick galvanized steel

Caps: Steel; 22 gauge minimum; 16 gauge at fire resistant elements

2.2 SLEEVES

A. Sleeves for Pipes through Non-fire Rated Floors: 18 gauge thick galvanized steel.

B. Sleeves for Pipes through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gauge thick galvanized steel.

C. Sleeves for Pipes through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed, refer to Division 7. Sleeves for below grade piping passing under footings: Class 52; ductile iron.

D. Sleeves for below grade piping passing through exterior walls - Mechanical Rubber Pipe Seals.

E. Stuffing Insulation: Glass fiber type; non-combustible; 3 lb. density.

F. Fire Safeing Sealant: Intumescent material capable of expanding up to 8 to 10 times when exposed to temperatures beginning at 250 °F. It shall have ICBO, BOCA I approved ratings to 3 hours per ASTM E814 (UL 1479). 3M Fire Barrier Caulk, Putty, strip and sheet forms.

PART 3 - EXECUTION

3.1 GENERAL

A. Install in accordance with manufacturer’s instructions.

3.2 FLASHING

A. All roof flashing shall be approved by the roof material contractor and be compatible with the roofing system warranty. Install in accordance with the roofing manufacturer's recommendations.

B. All pipes passing through the roof shall be flashed at the roof and shall extend at least 10 inches in all directions from the pipe and run vertically up the pipe not less than 12 inches above the roof. Each pipe shall be counter-flashed and made tight with counterflashing, extending down inside the pipe 1½ inches and lapping over outside flashing 3 inches or with a Zurn Z-196 vent fitting.

C. Flash all roof drains extending at least 18 inches in all directions from drain.

D. Floor drains not located in concrete slab on grade shall have 4 lb. lead flashing extending at least 18 inches in all directions from drain.

E. Flashing shall be coordinated with roofing system requirements and shall suit style and type of roofing and equipment/materials used. Roofing is not under Mechanical.

F. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

G. At single-ply roof membrane locations, roofing contractor shall be responsible for flashings and collars of penetrations and shall meet the requirements of the roofing manufacturers 30-year roofing guarantee.

3.3 SLEEVES

A. Provide sleeves for above grade piping penetrations of walls, roofs and floors.

B. See drawings and details for pipe sleeves.

C. Set sleeves in position in formwork. Provide reinforcing around sleeves.

D. Size sleeves large enough to allow for movement due to expansion and contraction but not less than (2) pipe sizes larger than piping run. Provide for continuous insulation wrapping, where required.

E. Where piping penetrates a roof, floor or wall, close off space between pipe and sleeve with 3 lb. Fiberglass insulation and elastomeric Sealant (air tight). This applies to all roofs, walls or floors regardless of fire rating. Refer to Division 7. Note: 3 lb. insulation not required at roof penetrations. Use fire safing sealant at penetrations of fire rated floors and walls.

F. Provide chrome plated cast brass, one piece escutcheons at all pipe penetrations of finished surfaces (walls, ceilings, floors). Provide security set screw.

G. Furnish and install waterproof sleeves on all piping penetrations through the floor slabs in mechanical room floor or any area where pipes pass through slabs where water

spillage could cause damage to ceilings below. Top of sleeve shall extend 2 inches above floor.

H. Sleeves are not required for core drilled holes.

END OF SECTION

SECTION 22 05 19

METERS AND GAUGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Pressure Gauges

B. Pressure Gauge Tappings

C. Stem Type Thermometers and Supports

D. Test Plugs and Kits

E. Gas Meters provided by Gas Purveyor

1.2 RELATED SECTIONS

A. Section 22 05 00 – Common Work Results for Plumbing

B. Section 22 10 00 – Plumbing Piping

1.3 REFERENCES

A. Pressure Gauges
   1. ASME B40.1 - Gauges - Pressure Indicating Dial Type - Elastic Element

1.4 SUBMITTALS FOR REVIEW (REFER TO SECTION 22 05 00)

A. General
   1. Provide manufacturer's data which indicates use, construction, operating range, total range, accuracy, and dimensions.
   2. Provide a Gauge Application Table indicating each different use of gauges and the gauge range to be utilized, including minimum and maximum measurement values.

1.5 OPERATION AND MAINTENANCE MATERIALS (REFER TO SECTION 22 05 00)

A. General: Include instructions for calibrating instruments.

1.6 PROJECT RECORD DOCUMENTS

A. Record actual locations of components and instrumentation.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Do not install instruments when areas are under construction, except for required rough-in, taps, supports and test plugs.

1.8 REGULATORY REQUIREMENTS

A. All piping, fittings, valves, fixtures, faucets and equipment containing or conveying potable water shall comply with the latest US Safe Drinking Water Act mandating any wetted surface of the above mentioned items shall not contain above 0.25% lead content by weighted average. All piping, fittings, valve and equipment containing or conveying potable water shall comply with NSF 61 G and NSF 372 or shall be provided with indication on submittals the manufacturer's declaration of self-certification.

1.9 EXTRA MATERIALS

A. Test kit

PART 2 - PRODUCTS

2.1 PRESSURE GAUGES (WATER SERVICE)

A. Manufacturers (Refer to Section 22 05 00):
1. Trerice
2. Weiss
3. Weksler
4. Tel Tru
5. Miljoco

B. Basis of Design: Trerice Series 600CB

C. Construction: ASME B40.1; 4½ inch dial; cast aluminum case; brass tube and socket; brass movement; painted aluminum dial with black graduations on white background; suitable for outdoor use; psi scale as appropriate for intended use; full scale accuracy of plus or minus 1 %. Lead free meeting NSF/ANSI 372 and 61.

2.2 PRESSURE GAUGE TAPPINGS

A. ¼ inch NPT brass ball valve rated for 250 psig; brass pressure snubber with ¼ inch NPT connections.

2.3 STEM TYPE THERMOMETERS AND SUPPORTS

A. Manufacturers (Refer to Section 22 05 00):
1. Duro
2. Trerice

3. Weiss
4. Weksler
5. Tel Tru
6. Miljoco

B. Basis of Design: Trerice Series BX9

C. Construction: Nine (9) inch tall, adjustable angle; blue colored organic spirit; lens front tube; UV protected clear acrylic window up to 300 °F and high strength glass above 300 °F; ¾ inch long NPT brass stem with 2½ inch insertion length; cast aluminum case with enamel or epoxy finish; cast aluminum adjustable joint with positive locking device; scale to suit application; well to suit service; full scale accuracy within 2 %; Fahrenheit scale as appropriate for intended use.

D. Supports: Brass separable sockets for thermometer stems with or without extensions as required.

2.4 TEST PLUGS AND KITS

A. Test Plug:
1. Manufacturers (Refer to Section 22 05 00):
   a. Flow Design
   b. MG Piping Products
   c. Pete's Plugs
   d. Sisco
   e. Trerice
2. Construction: ¼ inch NPT or ½ inch NPT brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with neoprene core for temperatures up to 200 °F; nordel core for temperatures up to 350 °F; viton core for temperatures up to 400 °F; brass extension for insulated pipe.

B. Test Kit:
1. Manufacturers: Same as noted above for Test Plugs.
2. Internally padded and fitted carrying case;
   a. Brass gauge adaptor with probe
   b. (1) dial face thermometer for 25-125 degree range
   c. (1) dial face thermometer for 0-220 degree range
   d. (1) pressure gauge for 0-100 psi

PART 3 - EXECUTION

3.1 GENERAL

A. Install in complete conformance with the manufacturer's instructions.

B. Coil and conceal excess capillary on remote element instruments.

C. Provide instruments with scale ranges selected according to service with largest appropriate scale.

D. Install gauges and thermometers in locations where they are easily read from normal operating level without crawling or climbing. Install vertical to 45 degrees off vertical.

E. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.

3.2 PRESSURE GAUGES

A. Provide pressure gauges where indicated on plans.

B. Install pressure gauges with snubbers. Provide ball valve to isolate each gauge. Extend nipples to allow clearances from insulation.

C. Install one pressure gauge per pump, (whether indicated on the drawings or not), with taps and isolation valves, points of connection shall be before strainers and on suction and discharge of pump; pipe to gauge.

3.3 PRESSURE GAUGE TAPPINGS

A. Install gauge taps/test plugs in piping; refer to related piping specifications sections.

B. At minimum, provide gauge taps/test plugs for the purposes of calibration of gauges and thermometers installed in this section and calibration of sensors installed for the Energy Management and Direct Digital Control System in Section 23 09 23.

C. Where gauges and sensors are located at the same hydraulic and thermal point in the piping system (i.e. a pressure gauge, temperature gauge and Section 23 09 23 located together) a single test plug may be provided.

D. Provide gauge taps/test plugs as follows:
1. Adjacent to pressure gauges
2. Adjacent to thermometers
3. Adjacent to pressure and temperature sensors provided in Section 23 09 23
4. Inlet and outlet of coil or equipment where pressure and temperature gauges are not furnished.
5. Where indicated on drawings.

3.4 STEM TYPE THERMOMETERS AND SUPPORTS

A. Provide thermometers where indicated on plans. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2½ inches for installation of thermometer sockets 24 inches on each side of the thermometer. Ensure sockets allow clearance from insulation.

3.5 TEST PLUGS AND KITS

A. Provide temperature and pressure test plugs where indicated on the plans.

B. Turn over test kit to the Owner at project closeout.

3.6 GAS METERS

A. Gas meter shall be provided by the local utility. Arrange and coordinate installation of gas meters provided by the local utility.

B. Install meters in accordance with the manufacturer's requirements.

C. Adhere to meter manufacturer and gas purveyor requirements for placement with respect to proximity of fittings/valves and inlet/outlet straight piping lengths.

END OF SECTION

SECTION 22 05 23

GENERAL DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. General Valves

B. Water Pressure Reducing Valves

C. Temperature and Pressure Relief Valves

D. Strainers

E. Flow Control Balance Valves

F. Gas Pressure Regulators

G. Access Doors

1.2 RELATED SECTIONS

A. Division 8 – Access doors

B. Section 22 05 00 – Common Work Results for Plumbing

C. Section 22 05 04 – Plumbing Specialties

D. Section 22 05 53 – Identification for Plumbing Piping and Equipment

E. Section 22 07 00 – Plumbing Insulation

F. Section 22 10 00 – Plumbing Piping

1.3 REFERENCES

A. General Valves
1. MSS SP-67 - Butterfly Valves
2. MSS SP-70 - Cast Iron Gate Valves, Flanged and Threaded Ends
3. MSS SP-71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends
4. MSS SP-78 - Cast Iron Plug Valves, Flanged and Threaded Ends
5. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves
6. MSS SP-85 - Cast Iron Globe & Angle Valves, Flanged and Threaded Ends
7. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

B. Gas Shutoff Valves
   1. AGA Z21.22 - Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems

1.4 SUBMITTALS FOR REVIEW

A. Submit under provisions of Section 22 05 00.

B. Product Data: Provide data on materials, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.

1.5 QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating marked on valve body.

1.6 REGULATORY REQUIREMENTS

A. All piping, fittings, valves, fixtures, faucets and equipment containing or conveying potable water shall comply with the latest US Safe Drinking Water Act mandating any wetted surface of the above mentioned items shall not contain above 0.25% lead content by weighted average. All piping, fittings, valve and equipment containing or conveying potable water shall comply with NSF 61 G and NSF 372 or shall be provided with indication on submittals the manufacturer's declaration of self-certification.

1.7 DELIVERY, STORAGE, AND HANDLING (REFER TO SECTION 22 05 00)

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary protective coating on cast iron and steel valves.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.8 DRAWING SCHEDULES

A. Refer to schedules on drawings for model numbers, symbols, etc. for additional information concerning products specified in this section.

PART 2 - PRODUCTS

2.1 GENERAL VALVES

A. Manufacturers (Refer to Section 22 05 00):

1. Crane
2. Jenkins
3. Powell
4. Milwaukee
5. Grinnell
6. Stockham
7. Hammond
8. Nibco
9. Walworth
10. Watts

B. Gate Valves
   1. Up to and including 2 inches:
      a. MSS SP-80, Class 125, bronze body, bronze trim, non-rising stem, handwheel, inside screw, solid wedge disc, solder or threaded ends
   2. 2½ inches and larger:
      a. MSS SP-70, Class 125, iron body, bronze trim, outside screw and yoke, handwheel, solid wedge disc, flanged ends. Provide chain-wheel operators for valves 6 inches and larger mounted over 8 feet above floor—OS&Y.

C. Ball Valves
   1. Up to and including 3 inches:
      a. MSS SP-110, Class 150, 400 psi, bronze two piece body, chrome plated brass ball, regular port, Teflon seats and stuffing box ring, blow-out proof stem, lever handle, solder or threaded ends with union.

D. Gas Valves
   1. Up to and including 2 inches:
      a. Bronze butterball butterfly valve: bronze body, lever handle, stainless steel disc and stem, viton seal, 175 psig WOG, MSS SP-67, AGA certified and UL listed for gas service.
   2. 2½ inches to 4 inches:
      a. Square head stop, standard pattern, cast iron body and plug, non-lubricated, inert packing material, threaded ends with union. Hays No. 7005 or equal.

E. Butterfly Valves
   1. 2 inches and larger:
      a. MSS SP-67, 200 psi, bronze body, 316 stainless steel disc, resilient replaceable Buna N seat, wafer or lug ends, extended neck, stainless steel stem, infinite position lever handle with memory stop. Provide gear operators for valves 8 inches and larger, and chain-wheel operators for valves mounted over 8 feet above floor.

F. Swing Check Valves
   1. Up to and including 2 inches:
      a. MSS SP-80, Class 125, bronze body and cap, bronze swing disc with rubber seat, solder ends
   2. 2½ inches and larger:
      a. MSS SP-71, Class 125, iron body, bronze swing disc, renewable disc seal and seat, flanged ends

2.2 WATER PRESSURE REDUCING VALVES

A. Up to 2 inches:
   1. Manufacturers (Refer to Section 22 05 00):
      a. Watts
      b. Wilkins
   2. Bronze body, stainless steel and thermoplastic internal parts, fabric reinforced diaphragm, strainer, threaded and double union ends. ANSI A112.26.2, A.S.S.E. I.A.P.M.O. listed.
   3. Maximum Temperature Capability: 160 °F
   4. Maximum Initial Pressure: 300 psi
   5. Adjustable Pressure Range: 25 to 75 psig

2.3 TEMPERATURE AND PRESSURE RELIEF VALVES

A. Temperature and Pressure Relief:
   1. Manufacturers (Refer to Section 22 05 00):
      a. Watts
      b. Wilkins
      c. Bell & Gossett
   2. Tested under ANSI Z21.22 with ratings as certified and listed by A.G.A. and C.G.A., bronze body, Teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, temperature relief maximum 210 °F, capacity ASME SEC IV certified and labeled.

2.4 STRAINERS

A. Up to 2 inches:
   1. Manufacturers (Refer to Section 22 05 00):
      a. Watts
      b. Wilkins
      c. Spirax Sarco
   2. Threaded brass body for 125 psi, at 400 °F, Y pattern with 3/64 inch stainless steel perforated screen

B. 2½ inches to 4 inch:
   1. Manufacturers (Refer to Section 22 05 00):
      a. Watts
      b. Wilkins
   2. Class 125, flanged iron body, Y pattern with 1/16 inch stainless steel perforated screen

2.5 FLOW CONTROL BALANCE VALVES (CIRCUIT SETTERS):

A. Manufacturers (Refer to Section 22 05 00):
   1. Bell and Gossett “Circuit Setter Plus”
   2. Taco

3. Armstrong

B. Calibrated, plug type balance valve with precision machined orifice, readout valves equipped with integral check valves and gasketed caps, calibrated nameplate and indicating pointer—Brass or bronze body. Lead free-ANSI/NSF compliant.

2.6 GAS PRESSURE REGULATORS

A. Manufacturers (Refer to Section 22 05 00):
1. Fisher
2. Jordan
3. Rockwell

B. Spring loaded with internal relief valve. Cast iron body rated for 150 psi (non-operational) with screened vent.

C. Size, capacity and pressure requirements in accordance with drawings

2.7 ACCESS DOORS

A. Materials shall be in accordance with Division 8.

PART 3 - EXECUTION

3.1 PREPARATION

A. Remove scale and dirt, on inside and outside, before assembly.

3.2 INSTALLATION – GENERAL

A. Provide valves in accordance with manufacturer's instructions and as indicated on the drawings.

B. Allow for sufficient space above removable ceiling panels to allow for ceiling panel removal.

C. Provide clearance from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 22 07 00.

D. Provide access doors where valves, strainers, regulators etc., are not exposed unless indicated to be provided under other divisions. Access doors shall comply with Division 8.

E. Install valves with stems upright or horizontal, not inverted.

F. Valves shall be line size unless indicated otherwise.

3.3 APPLICATION

A. Provide ball or butterfly valves for shut-off and to isolate equipment, part of systems, or vertical risers. Note: Ball valves shall be limited to pipe sizes 2 inches and smaller.

B. Provide globe, ball or butterfly valves for throttling, bypass, or manual flow control services.

C. Provide lug end butterfly valves adjacent to equipment when provided to isolate equipment, for pressure reducing valves and meters as indicated on drawings.

D. Provide listed gas shutoff valves in natural gas systems for shut-off service.

E. Provide flow control balance valves (circuit setters) in domestic hot water recirculating systems where indicated.

F. Provide gate valves for main domestic water shutoff.

G. Provide isolation shutoff valves and unions at inlet and outlet sides of all water pressure reducing valves and gas pressure regulators.

END OF SECTION

SECTION 22 05 29

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Inserts

B. Pipe Hangers and Supports

C. Pipe Insulation Shields

D. Resilient Clamps

E. Equipment Supports

1.2 RELATED SECTIONS

A. Division 3 – Cast-In-Place Concrete

B. Division 7 - Thermal and Moisture Protection

C. Section 22 05 00 –Common Work Results for Plumbing

D. Section 22 05 23 – General Duty Valves for Plumbing Piping

E. Section 22 05 48 – Vibration Isolation

F. Section 22 07 00 – Plumbing Insulation

G. Section 22 10 00 – Plumbing Piping

H. Section 22 15 00 – General Service Compressed Air Systems

I. Section 22 30 00 – Plumbing Equipment

1.3 REFERENCES

A. General
1. ASME B31.2 - Fuel Gas Piping
2. ASME B31.5 - Refrigeration Piping
3. ASME B31.9 - Building Services Piping

B. Pipe Hangers and Supports
1. ASTM F708 - Design and Installation of Rigid Pipe Hangers
2. MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacturer

3. MSS SP69 - Pipe Hangers and Supports - Selection and Application
4. MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices

1.4 SUBMITTALS FOR REVIEW (REFER TO SECTION 22 05 00)

A. Product Data: Provide manufacturers catalog data including load capacity.

B. Manufacturer's Installation Instructions: Indicate special procedures and assembly of components.

1.5 REGULATORY REQUIREMENTS

A. Pipe Hangers and Supports
1. Hanger and support systems shall conform to MSS SP58, MSS SP69, MSS SP89

PART 2 - PRODUCTS

2.1 INSERTS

A. Construction: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment; top slot for reinforcing rods; lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.2 PIPE HANGERS AND SUPPORTS

A. Manufacturers (Refer to Section 22 05 00):
1. Grinnell/Anvil
2. ERICO/Michigan Hanger
3. Crane
4. Fee and Mason

B. Plumbing Piping – DWV
1. Conform to MSS SP58, MSS SP69, and MSS SP89.
2. Hangers for Pipe Sizes ½ to 1½ inches: Carbon steel, adjustable swivel, split ring.
3. Hangers for Pipe Sizes 2 inches and over: Carbon steel, adjustable, clevis.
4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
5. Wall Support for Pipe Sizes to 3 inches: Cast iron hook.
6. Wall Support for Pipe Sizes 4 inches and over: Welded steel bracket and wrought steel clamp.
7. Vertical Support: Steel riser clamp.
8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
9. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

C. Plumbing Piping – Water (Copper/Steel Pipe):
1. Conform to MSS SP58, MSS SP69, and MSS SP89.
2. Hangers for Pipe Sizes ½ to 1½: Carbon steel, adjustable swivel, split ring.

3. Hangers for Cold Pipe Sizes 2 inches and over: Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe Sizes 2 to 4 inches: Carbon steel, adjustable, clevis.
5. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
6. Wall Support for Pipe Sizes to 3 inches: Cast iron hook.
7. Wall Support for Pipe Sizes 4 inches and over: Welded steel bracket and wrought steel clamp.
8. Vertical Support: Steel riser clamp.
9. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
10. Swivel ring, clamps and all materials in contact with the pipe shall be plated to match copper pipe material.

D. Natural Gas Piping Systems
1. Conform to MSS SP58, MSS SP69, and MSS SP89.
2. Hangers for Pipe Sizes ½ to 8 inches: Carbon steel, plated adjustable swivel, ring.
3. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
4. Vertical Support: Steel riser clamp.
5. Swivel ring, clamps and all materials in contact with the pipe shall be plated to match copper or stainless steel pipe material.

E. Compressed Air Piping System.
1. Conform to MSS SP58, MSS SP69, and MSS SP89.
2. Hangers for Pipe Sizes ½ to 8 inches: Carbon steel, plated adjustable swivel, ring.
3. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
4. Vertical Support: Steel riser clamp.
5. Swivel ring, clamps and all materials in contact with the pipe shall be plated to match copper or stainless steel pipe material.

F. Pipe Riser Clamps
1. Steel and Cast Iron Pipe: Extension pipe or riser clamp; carbon steel; black or galvanized finish.
   a. Basis of design: Grinnell Fig 261.
2. Copper Pipe: Copper tubing riser clamp; carbon steel; copper finish.
   a. Basis of design: Grinnell Fig CT-121.

2.3 HANGER RODS

A. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

2.4 PIPE INSULATION SHIELDS

A. Manufacturers (Refer to Section 22 05 00):
1. Grinnell
2. Fee & Mason
3. M-Co
4. Pipe Shields, Inc.
5. Kin-Line

B. Hot Piping (insulated pipe, 2 ½" and larger): Protection saddle type; size to suit thickness of insulation; curved carbon steel plate; Grinnell Fig 160, 161, 162.

C. Hot Piping (up to 2"): Insulation protection shield type; carbon steel; galvanized finish; Grinnell Fig 167.

D. Cold Piping: Insulation protection shield type; carbon steel; galvanized finish; Grinnell Fig 167.

2.5 RESILIENT CLAMPS

A. Manufacturers (Refer to Section 22 05 00):
1. Hydra-Zorb

B. Construction: Resilient cushion with clamps and anchoring channel.

2.6 ROOF PIPE SUPPORTS - STRUT CHANNEL SUPPORT STANDS

A. Manufacturers (Refer to Section 22 05 00)
1. Unistrut Unipier Rooftop Pipe Support System
2. MAPA
3. Miro Industries

B. Polycarbonate base with carbon black pigment for UV resistance or stainless steel base as required for load. Rounded edges to prevent gouging of roof membrane.

C. Base for supports shall be single base, double base or heavy duty double base trapeze as detailed on drawings or required for weight/duty of pipe supports.

D. Support pad (minimum 1/8" thick) between base and roofing to protect roofing, maximum loading 5 psi.

E. Supports shall hot dipped galvanized and have adjustable heights. Heights shall allow for mounting of pipe and equipment above snow levels. Supports shall allow for single or multiple pipes in for single tier or multiple tier installations

F. All thread shall be stainless steel with size to support weight of supported pipe or equipment.

PART 3 - EXECUTION

3.1 GENERAL

A. Install in accordance with manufacturer's instructions.

B. Piping shall be installed in such a manner that it is not in contact with metal building components.

C. Provide neoprene or approved wrap between water piping and metal building components, unistrut or other metal.
1. Exceptions:

a. Not required where piping is isolated from hangers with insulation shields.
b. Not required where resilient clamps are used.

D. Concrete housekeeping pads for mechanical equipment are not under Mechanical. Coordinate required location and size with other divisions and provide equipment shop drawings for proper sizing.

E. Provide templates, anchor bolts, and accessories for mounting and anchoring to other divisions as applicable.

F. Construct supports of steel members. Brace and fasten with flanges bolted to structure.

G. Provide rigid anchors for pipes after vibration isolation components are installed.

3.2 INSERTS

A. Provide inserts for placement in concrete formwork.

B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.

D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab in concealed areas and recessed into and grouted flush with slab in exposed areas.

3.3 PIPE HANGERS AND SUPPORTS

A. Support horizontal piping in accordance with applicable codes and the table at the end of this section.

B. Install hangers to provide minimum ½ inch space between finished covering and adjacent work.

C. Place hangers within 12 inches of each horizontal elbow.

D. Use hangers with 1½ inch minimum vertical adjustment.

E. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.

F. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

G. Support riser piping independently of connected horizontal piping.

H. Provide copper plated hangers and supports for copper piping.

I. Design hangers for pipe movement without disengagement of supported pipe.

J. Prime coat exposed steel hangers and supports. (Refer to division 9). Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

K. Support vertical piping at every floor penetration with pipe riser clamps.

L. Support vertical cast iron pipe at each floor at hub.

M. Support risers independently of connected horizontal piping.

N. Provide vibration isolation at supports when required by Section 23 05 48.

O. Provide seismic bracing for pipes as required. Refer to Section 23 05 49.

P. Install gas piping on “Roof Pipe Supports”. See details on plans.

3.4 PIPE INSULATION SHIELDS

A. Provide shields to protect pipe insulation at hangers. (Furnished and installed under Section 22 05 29.)

B. Size hangers to accommodate pipe insulation and insulation shields where applicable. See Section 22 07 00.

3.5 PIPE INSULATION INSERTS

A. Furnished under Section 22 07 00, installed under Section 22 05 29.

3.6 RESILIENT CLAMPS

A. Use to attach tubing, pipe, or hoses to vibrating machinery or equipment.

B. Use to isolate piping from contact with other metals, steel partition studs.

3.7 EQUIPMENT SUPPORTS

A. Provide supports and attachments to structure as required for installation of equipment. Supports shall be for base mounted or suspended applications to suit project conditions or as indicated on drawings.

B. Supports shall comply with Section 22 05 48.

PART 4 - TABLES

Pipe Size (inches)	Max. Horizontal Spacing for Hangers (feet)			Hanger Rod Dia. (inches)
	Threaded or Welded Joints		Copper Tube and Piping (soldered, brazed or welded joints)	
	Steel (excluding gas)	Steel (gas)		
½	10	6	6	3/8
¾	10	8	6	3/8
1	10	8	6	3/8
1¼	10	10	6	3/8
1½	12	10	6	3/8
2 to 3	12	10	10	½
4 to 6	12	10	10	5/8
8 to 12	12	10	10	7/8

Notes:

1. Cast iron pipe shall be suspended in accordance with the Idaho Plumbing Code Vertical piping shall be supported in accordance with the Idaho Plumbing Code
2. Horizontal cast iron hub-less piping shall be supported at every other joint unless that pipe exceeds 4 feet in length. In that case, the pipe shall be supported within 18 inches of each side of the joint.
3. Gas piping 1 ¼" and larger shall be supported at every floor level.
4. For other piping Materials, support in accordance with the requirements of the Idaho Plumbing Code and the manufacturer's requirements.

END OF SECTION

SECTION 22 05 48

VIBRATION ISOLATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Neoprene Waffle Pads

B. Flexible Pipe Connections

C. Restrained Spring Isolators

1.2 RELATED SECTIONS

A. Division 3

B. Section 22 05 00 – Common Work Results for Plumbing

C. Division 22 Piping/Equipment as specified herein.

1.3 REFERENCES

A. 1999 ASHRAE Handbook, Vibration Isolation

1.4 PERFORMANCE REQUIREMENTS

A. Provide minimum static deflection of isolators for equipment as indicated.
   1. 400 - 600 rpm: 3.5 inch
   2. 601 - 800 rpm: 2 inch
   3. 801 - 900 rpm: 1 inch
   4. 901 - 1500 rpm: 0.5 inch
   5. Over 1500 rpm: 0.2 inch

1.5 SUBMITTALS FOR REVIEW (REFER TO SECTION 22 05 00)

A. Product Information: Provide material and type of construction. Provide schedule of vibration isolator type with location and load on each.

B. Manufacturer’s Installation Instructions: Indicate special procedures and setting dimensions.

PART 2 - PRODUCTS

2.1 GENERAL ISOLATORS

A. Manufacturers (Refer to Section 22 05 00):
   1. Amber Booth
   2. Kinetics
   3. Korfund
   4. Mason Industries
   5. Vibroacoustics
   6. Isolators provided by the manufacturer of isolated equipment as an accessory to that equipment are acceptable when indicated in these specifications or on the drawings to be provided with isolation equipment as an accessory to the equipment.

B. Neoprene Waffle Pads: Minimum ¾ inch thick; maximum loading 40 psi.
   1. Basis of Design: Mason “Super W”

C. Restrained Spring Isolators: Restrained mount, capable of limiting horizontal movement of vibration isolated equipment without interfering with the equipment isolation during normal loading and operation. Isolator shall incorporate a neoprene noise isolation element. Springs shall provide an additional travel to solid equal to 50 % of the rated deflection. Provide an assembly complying with seismic restraint requirements of emergency equipment as established by Code. Height savings brackets are considered part of the isolator assembly if required for isolator installation.
   1. Basis of Design: Mason Industries, type SSLFH, SSLR

D. Structural Steel Base: Structural steel rectangular base with cross members to prevent twisting where longest beam dimension exceeds 6 feet. Use height-saving brackets for side mounting of isolators.
   1. Basis of Design: Mason Industries, type WF

2.2 FLEXIBLE PIPE CONNECTORS

A. Flexible Pipe Connectors: Stainless Steel Hose
   1. Braided flexible stainless steel hose.
   2. Hose to be rated at a minimum of 250 psi at 250 degrees F.
   3. Hose to be installed horizontally and parallel to equipment shaft.
   4. Hose to have a minimum length of 18 inches.
   5. Hose for 2 inch pipe size and smaller to be equipped with male nipple fittings.
   6. Hose for 2½ inch pipe size and larger to be equipped with fixed steel flanges.
   7. Hose to be selected for operating pressure with 4:1 minimum safety factor.
   8. Acceptable Products:
      a. Model BSS by Mason
      b. Hyspan

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide in accordance with manufacturer's instructions.

B. Provide isolation for all motor driven equipment furnished in this project:
   1. Exceptions:
      a. In-line circulating pumps

C. Connect wiring to isolated equipment with flexible hanging loop.

D. Schedule:
   1. Flexible piping Connectors: Provide at piping connections to:
      a. Air compressors
   2. Seismic Spring Isolators, Structural Steel Base and Neoprene Pad. Provide for equipment as follows. (Steel base may be omitted if equipment is provided with a structural steel base.)
      a. Air Compressors

END OF SECTION

SECTION 22 05 53

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Nameplates

B. Ceiling Markers

C. Pipe Markers

D. Tags

E. Tag Chart

1.2 RELATED SECTIONS

A. Section 22 05 00 – Common Work Results for Plumbing

B. Mechanical Piping, Valves, Equipment, and Control Sections

1.3 REFERENCES

A. ASME A13.1 - Scheme for the Identification of Piping Systems

1.4 SUBMITTALS FOR REVIEW (REFER TO SECTION 22 05 00)

A. Submit list of wording, symbols, letter size, and color coding for mechanical identification of all systems and equipment.

B. Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer’s name and model number.

C. Product Data: Provide manufacturers catalog literature for each product required.

1.5 OPERATION AND MAINTENANCE MATERIALS (REFER TO SECTION 22 05 00)

A. Include valve tag identification schedule.

1.6 REGULATORY REQUIREMENTS

A. Conform to Uniform Plumbing Code (Section 601) for signage and labeling requirements for potable and non-potable water systems.

PART 2 - PRODUCTS

2.1 NAMEPLATES

A. Description: Laminated three-layer plastic with engraved white letters on black background
   1. Exception: Nameplates for labeling non-potable outlets shall be posted with black uppercase lettering on a white background.

2.2 CEILING MARKERS

A. Manufacturers (refer to Section 23 05 00):
   1. Marking Services (MSI)
   2. Pipe Marker

B. Indoors: Durable, engraved plastic, black backgrounds and colored lettering. 1/16" plastic stock with adhesive backing.

C. Outdoors, laminated three-layer with engraved white letters on black ground with mounting holes.

D. Directional arrows to indicating which ceiling tile is to be removed for service.

E. Tag colors:
   1. HVAC Equipment: Orange
   2. Fire Dampers/Smoke Dampers-Red
   3. Heating/cooling valves-Blue
   4. Plumbing Valves-Green
   5. Plumbing Cleanouts and equipment-White
   6. Controls-Yellow

2.3 PIPE MARKERS

A. Manufacturers: (Refer to Section 22 05 00):
   1. W.H. Brady
   2. Seton
   3. Marking Services, Inc.

B. Color and Lettering: Conform to ASME A13.1 and Uniform Plumbing Code Section 601. The Uniform Plumbing Code shall take preference over ASME 13.1 in the event of a conflict.

C. Markers shall identify fluid or gas type, have colored bands with background color in spacing required in Part 3, and the direction of normal flow.
   1. Potable water systems shall have green background with white letters.
   2. Minimum color field length and minimum letter size per the Uniform Plumbing Code.

D. Plastic Pipe Markers: Factory fabricated; flexible; semi-rigid plastic; preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.

E. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

F. Plastic Underground Pipe Markers: Bright colored continuously printed plastic ribbon tape; minimum 6 inch wide by 4 mil thick; manufactured for direct burial service. Provide metallic tracer wire imbedded in tape on non-metallic piping systems.

2.4 TAGS

A. Description: Brass or Aluminum with stamped letters; tag size minimum 1½ inch diameter with smooth edges. Provide ¼” letters for piping system abbreviation and ½” sequenced numbers. Provide 1/8” hole for fastener.

2.5 TAG CHART

A. Description: Typewritten letter size list in aluminum frame, plastic laminated. Chart shall include valve number, service and location.

PART 3 - EXECUTION

3.1 GENERAL

A. Install in accordance with manufacturer’s recommendations.

3.2 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Provide identifying devices after completion of coverings and painting.

3.3 NAMEPLATES/LABELS

A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive.

B. Install labels with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.

3.4 PIPE MARKERS

A. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe. Provide metallic tracer wire imbedded with pipe markers for non-metallic piping systems installed outside of the building footprint.

3.5 TAGS

A. Install tags using corrosion resistant chain. Number tags consecutively by location.

3.6 SCHEDULE

A. Identify all scheduled equipment (pumps, heat transfer equipment, tanks, compressors etc.) and water treatment devices with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags. The plastic nameplates shall be large enough such that the structure hung equipment (gas regulators, compressors) is identifiable while standing on grade.

B. Provide ceiling markers on t-bar and access panels to locate valves, fan coils, air terminal units and automatic (motorized) dampers above T-bar type panel ceilings and behind. Install adhesive ceiling markers to t-bar grid or access panel to indicate equipment and valve locations installed above ceilings. Provide direction arrows indicating ceiling tile requiring removal for service.

C. Identify control panels and major control components outside panels with plastic nameplates.

D. Identify valves in main and branch piping with tags. Exception: check valves, valves with factory-fabricated equipment units.

E. Identify piping, concealed or exposed, with plastic pipe markers or plastic tape pipe markers. Identify service, flow direction, and pressure (when applicable). Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet (but not less than one per room) on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

F. Provide tagged valve schedule (individual to each building) to the owner.

END OF SECTION

SECTION 22 07 00

PLUMBING INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Pipe and Equipment Insulation

B. Inserts and Shields – Installation

C. Jackets and Fitting Covers

1.2 RELATED SECTIONS

A. Section 22 05 00 – Common Work Results for Plumbing

B. Section 22 05 17 – Sleeves and Sleeve Seals for Plumbing Piping

C. Section 22 05 23 – General Duty Valves for Plumbing Piping

D. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment

E. Section 22 05 53 – Identification for Plumbing Piping and Equipment

F. Section 22 10 00 – Plumbing Piping

G. Section 22 30 00 – Plumbing Equipment

1.3 REFERENCES

A. General
1. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials
2. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials
3. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials
4. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials

B. Glass Fiber
1. ASTM C547 - Standard Specification for Mineral Fiber Preformed Pipe Insulation

C. Jackets and Fitting Covers
1. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

2. ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation
3. ASTM D1784 - Standard Specification for Rigid Polyvinyl Chloride (PVC) Compounds Chlorinated Polyvinyl Chloride (CPVC) Compounds

1.4 SUBMITTALS FOR REVIEW (REFER TO SECTION 22 05 00)

A. For each insulation type, provide material characteristics, minimum and maximum service temperatures, moisture absorption characteristics, thermal and vapor transmission characteristics.

B. Provide a schedule indicating insulation type and thickness for all pipe sizes of all piping systems.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

B. Applicator Qualifications: Company specializing in performing the work of this section with minimum three (3) years documented experience and who is authorized by the manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Transport, handle, store, and protect products in accordance with Section 22 05 00.

B. Accept materials on site, labeled with manufacturer’s identification, product density, and thickness.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient conditions required by manufacturers of each product.

B. Maintain temperature before, during, and after installation for minimum of twenty-four (24) hours.

1.8 REGULATORY REQUIREMENTS

A. Conform to flame spread/smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255, and UL 723. This shall apply to insulation as well as to all accessories including but not limited to adhesives, mastics, jackets, cements, tapes, cloth for fittings, etc.

PART 2 - PRODUCTS

2.1 GLASS FIBER INSULATION (PIPING)

A. Manufacturers (Refer to Section 22 05 00):
   1. Johns Manville, Micro-Lok, AP-T Plus
   2. Knauf
   3. Owens Corning

B. Insulation: ASTM C547; rigid molded; noncombustible; *k* factor: ASTM C177, 0.24 Btu·in/(h·ft²·°F) at 75 °F; 850 °F maximum service temperature; 0.2 percent maximum moisture absorption by volume.

C. Vapor Barrier Jacket: White kraft paper with glass fiber yarn; bonded to aluminized film with pressure sensitive tape lap sealing system; moisture vapor transmission: ASTM E96; 0.02 perm-inches.

D. Provide with GreenGuard Certification for Children and Schools.

2.2 JACKETS AND FITTING COVERS (PIPING)

A. PVC Plastic Jacket and Fitting Covers (Interior Applications):
   1. Manufacturers (Refer to Section 22 05 00):
      a. Zeston 2000
   2. Jackets and fitting covers: ASTM D1784; one piece molded type fitting covers and sheet material; off-white color; minimum service temperature: 0 °F; maximum service temperature: 450 °F; thickness: 20 mil.
   3. Jackets and fitting covers (vapor barrier jackets): ASTM D1784; one piece molded type fitting covers and sheet material; off-white color; minimum service temperature: 0 °F; maximum service temperature: 450 °F; moisture vapor transmission - ASTM E96 - 0.002 perm-inches; thickness: 20 mil.
   4. Connections: Pressure sensitive color matching vinyl tape

2.3 INSERTS AND SHIELDS

A. Inserts: Heavy density insulation which will not crush from weight of pipe. Locate between shield and pipe. Inserts are furnished in this Section 22 07 00 and installed in Section 22 05 29.

B. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and insulation. Shields are furnished and installed under Section 22 05 29.

2.4 GLASS FIBER INSULATION (EQUIPMENT)

A. Manufacturers (Refer to Section 22 05 00):
   1. Johns Manville - Pipe and Tank Insulation
   2. Owens Corning

B. Insulation: Semi-rigid, noncombustible; *k* factor: ASTM C335 0.27 Btu·in/(h·ft²·°F) at 75 °F; maximum service temperature: 650 °F; density: 3.0 pounds/foot³.

C. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film with pressure sensitive tape lap sealing system; moisture vapor transmission: ASTM E96; 0.02 perm-inches.

2.5 REUSABLE VALVE COVERS (PIPING)

A. Manufacturers (Refer to Section 22 05 00):
1. No Sweat Valve Wraps

B. Insulation shall have a minimum k- factor .26, using fiberglass blanket. Flame and smoke spread shall be 25/50 per ASTM E-84.

C. Outer jacket shall be made of material equal to DuPont Tychem® QC, overlapping and completely covering the insulation with seams joined by tabs made from hook and loop fasteners (Velcro). Butt ends shall have sewn- in-place elastic.

D. Outer jacket shall overlap adjoining sections of pipe insulation.

E. Installation shall not require the use of any special hand tools.

F. Suitable for continuous operation at 200 degrees Fahrenheit.

PART 3 - EXECUTION

3.1 EXAMINATION – GENERAL

A. Verify that piping has been tested and approved before applying insulation materials.

B. Verify that surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION – GENERAL (PIPING)

A. Continue insulation with vapor barrier through penetrations.

B. On exposed piping in finished areas, locate insulation and cover seams in least visible locations.

C. Insulate pipes in accordance with the insulation schedule.

D. On insulated piping with vapor barrier, insulate fittings, valves, unions, flanges, strainers, flexible connections and expansion joints.

E. On insulated piping without vapor barrier for pipes conveying fluids 180° F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation at such locations.

F. Install materials in accordance with the manufacturer's instructions.

G. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions.

H. Insulation on all cold water systems shall be applied with a continuous unbroken vapor seal.

I. Do not allow hangers, supports, anchors etc., to come in direct contact with the pipe.

J. Insulate entire system including fittings, unions and flexible connections, flanges and expansion joints. For insulation of valves and other pieces of equipment, see Section 22 07 00. At fire separations, Refer to Section 22 05 17 and Division 7 - Fire Stopping.

K. Insulation shall not be applied until system is tested, cleaned and approved.

3.3 GLASS FIBER INSULATION (PIPING)

A. Cover pipe with glass fiber insulation in thickness scheduled.

B. When vapor barrier is required, adhere factory applied vapor barrier jacket lap smoothly and securely at longitudinal laps with pressure sensitive strip. Adhere self-sealing butt joint strips over end joints. No staples will be allowed.

C. Insulate fittings and joints with molded insulation of like material and thickness of adjacent pipe with ends of insulation tucked snugly into throat of fitting and edges adjacent to pipe insulation tufted and tucked in.

D. Cover insulation with one piece PVC fitting covers.

3.4 JACKETS AND FITTING COVERS (PIPING)

A. Apply insulation prior to installation of jackets and fitting covers.

B. Pipe exposed in finished spaces less than 10 feet above finished floor, and where indicated on drawings: finish with PVC jacket and fitting covers.

C. Secure PVC jackets and fitting covers with stainless steel tacks and wrap seams and tacks with vinyl tape.

3.5 INSERTS AND SHIELDS

A. Inserts: Heavy density insulation which will not crush from weight of pipe. Locate between shield and pipe. Inserts are furnished in this Section 22 07 00 and installed in Section 22 05 29.

B. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and insulation. Shields are furnished and installed under Section 22 05 29.

3.6 ROOF DRAIN SUMPS

A. Insulate with fiberglass batt sealed with tape and adhesive vapor tight.

3.7 EXAMINATION (EQUIPMENT)

A. Verify that equipment has been tested before applying insulation materials.

B. Verify that surfaces are clean and dry, with foreign material removed.

3.8 INSTALLATION (EQUIPMENT)

A. General
1. Provide materials in accordance with the manufacturer's recommendations.
2. Factory Insulated Equipment: Do not insulate.
3. Finish insulation at supports, protrusions, and interruptions.
4. Nameplates and ASME Stamps: Bevel and seal insulation around with a mastic. Do not insulate over.
5. Exposed Equipment in Finished Areas: Locate insulation and cover seams in least visible locations.
6. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Insulate with removable blankets and covers.
7. Valves, strainers, circuit setters and other piped in-line specialties requiring service: insulate with reusable valve covers.

3.9 GLASS FIBER INSULATION (EQUIPMENT)

A. Cover equipment with glass fiber insulation in thickness scheduled.

B. Provide vapor barrier jackets. Adhere factory applied vapor barrier jacket lap smoothly and securely at longitudinal laps with pressure sensitive strip. Adhere self-sealing butt joint strips over end joints. No staples will be allowed.

3.10 HANDICAPPED FIXTURES

A. All exposed hot and drain piping at Handicap fixtures shall be insulated with a neatly installed removable type ADA – See Section 22 40 00.

PART 4 - SCHEDULES

4.1 SCHEDULES

A. Insulate equipment including valves, tanks, air removal devices, etc.

B. Plumbing equipment, filters, etc., not factory insulated, shall be insulated under this section.

C. Expansion tanks and similar equipment not receiving fluid directly from the system do not require insulation.

D. Valves, traps, pressure reducing valves, pumps, , etc.: Extend insulation 6 inches beyond flanges.

4.2 EQUIPMENT

A. Systems Above Ambient Temperature: 2 inch thick glass fiber insulation with vapor barrier.

B. Systems Below Ambient Temperature: ½ inch thick glass fiber insulation with vapor barrier. Exception: Insulate pump bodies on systems below ambient temperature with 1 inch thick cellular foam insulation.

C. All equipment requiring access for maintenance, repair or cleaning shall be insulated with lace-on blankets.

4.3 SCHEDULES - PIPING

Insulation Schedule - Piping

System	Operating Temperature (degrees F)	Insulation Type	Pipe Size (inches)	Insulation Thickness (inches)	Notes
Domestic Hot Water, Hot Water Re-circ and Non-Potable Hot Water and Non-Potable Hot Water Recirc (above ground)	105 to 140	glass fiber	Under 1½	1	
			1½ and greater	1½	
Domestic Cold Water and Non-Potable Cold Water (above ground)	—	glass fiber	Under 1 ½”	½	
			1 ½” and greater	1	
Roof and Overflow Drain Piping and Roof Drain Sumps	—	glass fiber	all	1	—

Notes:

END OF SECTION

SECTION 22 08 00

COMMISSIONING OF DOMESTIC WATER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Attention is directed to the printed form of Contract and General Conditions and Supplementary Conditions which are hereby made a part of this Section of the Specifications

B. Furnish all labor, materials, equipment and services necessary to provide the owner with fully functional domestic water system.

C. Commissioning: Commissioning (Cx) is a quality-oriented process for achieving, verifying, and documenting that the performance of facilities, systems, and assemblies meet the defined objectives and criteria set by the Owners.

D. Commissioning Team: The members of the Cx team consist of the owner's contracted commissioning authority (CxA), the owner's representative or construction manager (CM), the general contractor (GC), the architect (Arch) and the design engineers (Engs), the mechanical Contractors (MC), the electrical contractor (EC), the testing and balancing (TAB) contractor, the control contractor (CC), the facility operating staff, and any other subContractors or suppliers of equipment. The CxA directs and coordinates the project Cx activities and reports to the owner. All team members work together to fulfill their contracted responsibilities and meet the objectives of the contracted documents. Commissioning Shall:

1. Verify that applicable equipment and systems are installed according to the contract documents, manufacturer's recommendations, and industry accepted minimum standards and that they receive adequate operational checkout by installing Contractors.

2. Verify and document proper performance of equipment and systems.

3. Verify that O&M documentation left on site is complete.

4. Verify that the owner's operating personnel are adequately trained.

E. The Cx process does not take away from or reduce the responsibility of the system designers or installing Contractors to provide a finished and fully functional product. Furthermore, it doesn't not remove any responsibilities, products or requirements of other specification sections. This includes equipment startup by factory trained personnel.

F. The general or plumbing contractors are not required to provide the CxA. An independent, third-party commissioning agent has been retained by the State of Idaho. Though the contractor is not required to provide a commissioning agent,

requirements for participation in the commissioning process are included in this specification.

1.2 DESCRIPTION OF WORK

A. The work of this Section shall include and provide all labor, tools, materials and equipment necessary for the CxA to verify installation and performance of the Plumbing systems.

1.3 RELATED WORK IN OTHER SECTIONS

A. The following related work shall be furnished or performed under other Sections of these Specifications:
1. Section 019113 – GENERAL COMMISSIONING REQUIREMENTS

2. Section 019114 – COMMISSIONING PLAN

B. Commissioning Plan documentation is included by reference for information only.

C. ASHRAE Standard 202-2018

D. IECC 2018

1.4 DEFINITIONS

A. Commissioning Plan: The detailed set of checking and testing procedures, sequences of events, schedules, staffing plans, and management or administrative procedures required to provide a comprehensive coordinated approach for commissioning the systems and equipment described herein.

B. CxA: Commissioning Authority. The Commissioning Representative of the Owner. The Commissioning Authority will manage all commissioning activities on behalf of the Owner and will serve as the Owner’s agent in review and approval of commissioning related services.

C. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

D. Commissioning Representatives: Those members of the Contractor's staff, Subcontractor’s staff, Owner’s staff, Architect’s staff, or Owner's independent contractor assigned to participate in the commissioning process.

E. Commissioning Manager: The Commissioning Representative of the Contractor and/or commissioning team, to manage and lead the commissioning effort on behalf of the Contractor and/or commissioning team.

F. Commissioning Procedures: A series of checks, tests, and operational procedures, applied in specific sequences, to each system or equipment component to be commissioned and intended to demonstrate full system installation, performance, and functionality, in accordance with the design intent. The term “proce-

dures" shall be used throughout this specification and the Project Commissioning Plan in reference to these checking, testing, and operational procedures.

G. Systems Pre-Functional Test: A test, or tests, of the static function and operation of equipment and systems using manual (direct observation) by the installing contractor prior, during and post-equipment startup as deemed appropriate. Systems Pre-Functional Performance Testing is meant to verify the as-built systems ability to operate trouble free in at least a limited fashion prior to TAB and Systems Functional Performance testing. This process is documented through population of the provided pre-functional checklists.

H. Systems Functional Performance Test: A test, or tests, of the dynamic function and operation of equipment and systems using manual (direct observation) or monitoring methods meant to commence following the completion of TAB and Systems Pre-Functional Testing. Systems Functional Performance Testing is the dynamic testing of systems (rather than just components) under full operation (e.g., the circulation pumps are tied to a control system which turns it on/off) performed by the Commissioning Agent with support from the contractor as needed. Systems are tested under various modes, such as low and high demand conditions, component or power failures, etc. The systems are run through all the control system's sequences of operation and components are verified to be responding as the sequences state. Traditional water test and balancing (TAB) is not considered Systems Functional Performance Testing. TAB's primary work is setting up the system flows and pressures as specified, while System Functional Performance Testing is verifying that the system has already been set up properly and is functioning in accordance with the Construction Documents. The Commissioning Agent develops the Systems Functional Performance Test Procedures in a sequential written form, coordinates, witnesses, and documents the actual testing. Systems Functional Performance Testing is performed by the Contractor. Systems Functional Performance Tests are performed after startups, control systems are complete and operational, TAB functions and Pre-Functional Checklists are complete.

1.5 INTENT

A. It is the intention of this Specification is a to require the Contractors performing work to cooperate with the CxA, to furnish all labor and equipment and measuring devices, to perform required measurements and tests to verify that the installed equipment and systems are performing in accordance with the construction documents.

B. The CxA is not responsible for design concept, design criteria, compliance with codes, design or general construction scheduling, cost estimating or construction management.

C. Plumbing system installation, start-up, testing and balancing, preparation of O&M manuals, and operator training are the responsibility of the Plumbing Contractor, with coordination by the General Contractor, Construction Manager or other entity acting under the requirements of Division 1. Observation, verification and Cx are the responsibility of the CxA who is to be assisted by installing Contractors in system operation as needed. The Cx process does not relieve Contractors from the obligations to complete all portions of work in a satisfactory

and fully operational manner, nor does Cx remove any obligation the trades have for operation and maintenance manuals and training.

1.6 PLUMBING CONTRACTOR REQUIREMENTS

A. Cx, Pre-Functional and Functional testing as defined by ASHRAE standard 202-2018 are mandatory requirements of this project. All equipment and systems installed in connection with the section listed above shall be put in operation in the presence of duly authorized representatives with 48-hour notice given to the CxA.

B. All applicable equipment submittals shall be forwarded to the CxA for review.

C. No Functional Testing shall commence until the completion and submission of the populated pre-functional checklists to the CxA. The CxA will provide blank pre-functional testing forms for the contractor to populate. Pre-functional testing forms shall be provided to the CxA in submittal form.

D. No Functional Testing shall commence until all systems TAB is complete(if applicable). Functional testing may commence, at the discretion of the CxA, once TAB is complete however only conditional acceptance can be achieved until the final TAB report is provided by the contractor to the CxA for review. Only after review and acceptance of the TAB report and tested values can final acceptance be achieved. The owner may elect to wait until final acceptance is achieved to consider the project substantially complete.

E. The Cx responsibilities applicable to the plumbing subcontractor are as follows:

1. Provide startup for all equipment in the contracted scope by trained manufacturer representatives or personnel.

2. Assist and cooperate with the Testing and Balancing (TAB) contractor and the CxA by:

a. Putting all equipment and systems into operation and continuing the operation during each working day of TAB and Cx as required.

b. Providing clearances for test holes, petes plugs and temperature sensors in piping where directed by TAB and design drawings.

c. Providing temperature and pressure taps according to the Construction Documents for TAB and Cx testing.

3. List and clearly identify on the as-built drawings the locations of all P/T plugs, gauges, meters, sensors and all other such measure and verification devices.

4. Prepare a preliminary schedule for all pipe system testing, flushing and cleaning, equipment start-up and TAB start and completion for use by the CxA. Update the schedule as appropriate.

5. Notify the GC and CxA when pipe flushing, cleaning, fixture testing, major equipment startup and any TAB work will occur. Be responsible to notify the GC, ahead of time, when Cx activities not yet performed or not yet scheduled will delay construction. Be proactive in seeing that Cx processes are executed and that the CxA and GC both have the scheduling information needed to efficiently execute the Cx process.

6. Attend Cx scoping meetings and other meetings necessary to facilitate the Cx process.

7. Provide a copy of the O&M manuals and submittals of commissioned equipment, through normal channels, together during equipment submittals to the CxA for review and approval. See this specification section for additional information and requirements for the O&M manuals.

8. Contractors shall assist (along with the design engineers) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.

9. Review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.

10. Develop a full start-up and initial checkout plan using manufacturer's start-up procedures and the PFTs from the CxA for all commissioned equipment. Submit to CxA for review and approval prior to startup.

11. During the startup and initial checkout process, execute the plumbing-related portions of the PFTs for all commissioned equipment. Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the CxA.

12. Address current outstanding punch list items before functional testing. Water Pressure Testing and Water Testing and Balancing (TAB) shall be completed with discrepancies and problems remedied before functional testing of the respective air- or water-related systems.

13. Complete Prefunctional Test Checklists (PFTs) provided by the CxA and return these to the CxA.

14. Provide access for equipment to be tested, such as removing ceiling tiles.

15. Provide skilled technicians to execute starting of equipment and to execute the pre-functional performance tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem solving.

16. Provide skilled technicians to assist with functional performance testing under the direction of the CxA for specified equipment outlined in the Cx Plan. Assist the CxA in interpreting the monitoring data, as necessary.

17. Correct deficiencies (differences between specified and observed performance). The CxA will provide one (1) functional retest of commissioned equipment at no additional charge to the contractor(s). If repeated failures of the equipment and/or system require retest beyond the first retest, the contractor (s) will be back charged for the time of the CxA required to complete the additional retesting.

18. Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions. Provide assistance, cooperate and provide required materials to others as directed by the GC (and CxA) in the compilation of the O&M manuals. Prepare draft versions of the O&M Manual for use as the training syllabus.

19. During construction, maintain as-built red-line drawings for all drawings and final as-builts for contractor-generated coordination drawings. Update after completion of Cx (excluding deferred testing).

20. Provide Training Plan and training of the Owner's operating staff using expert qualified personnel, as specified. Use the draft O&M manual as the training manual.

21. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.

22. Attend Cx coordination meetings and provided assistance and cooperate in the preparation of a Cx schedule with the GC and CxA.

23. Cx Tasks shall be performed by the same personnel who were involved in the installation and are familiar with the equipment.

24. During the Warranty Period execute seasonal or deferred functional performance testing, witnessed by the CxA, according to the specifications and correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

1.7 RESPONSIBILITIES OF THE THIRD-PARTY COMMISSIONING AUTHORITY

A. Organize and lead the Cx team.

B. Prepare a construction-phase Cx plan. Collaborate with Contractors and with subContractors to develop test and verification procedures. Include design changes and scheduled Cx activities coordinated with overall Project schedule. Identify Cx team member responsibilities, by name, firm, and trade specialty, for performance of each Cx task.

C. Review and comment on submittals from Contractors for compliance with the OPR, BOD, Contract Documents, and construction-phase Cx plan. Review and

comment on performance expectations of systems and equipment and interfaces between systems relating to the OPR and BOD.

D. Convene Cx team meetings for the purpose of coordination, communication, and conflict resolution; discuss progress of the Cx processes. Responsibilities include arranging for facilities, preparing agenda and attendance lists, and notifying participants. The CxA shall prepare and distribute minutes to Cx team members and attendees within five workdays of the Cx meeting.

E. At the beginning of the construction phase, conduct an initial construction-phase coordination meeting for the purpose of reviewing the Cx activities and establishing tentative schedules for operation and maintenance submittals; operation and maintenance training sessions; manufacturer startup and Project completion.

F. Observe and verify construction and report progress and deficiencies. In addition to compliance with the OPR, BOD, and Contract Documents, verify systems and equipment installation for adequate accessibility for maintenance and component replacement or repair.

G. Prepare project-specific test and verification procedures and checklists.

H. Schedule, direct, witness, and document tests and verifications.

I. Compile test data, verification reports, and certificates and include them in the systems manual and Cx report.

J. Develop custom pre-functional testing protocol for review by interested parties.

K. Perform functional testing with assistance by appropriate contractors

L. Certify date of acceptance and startup for each item of equipment for start of warranty periods.

M. Review project record documents for accuracy. Request revisions from Contractor to achieve accuracy.

N. Review and comment on operation and maintenance documentation and systems manual outline for compliance with the OPR, BOD, and Contract Documents. Operation and maintenance documentation requirements are specified in Division 1 Section "Operation and Maintenance Data."

O. Review operation and maintenance training program and provide assessment and feedback on the completeness of the maintenance training program requirements. Operation and maintenance training is specified in contract documents

P. Assemble the final Cx documentation, including the Cx report and Project Record Documents.

1.8 SYSTEMS TO BE COMMISSIONED

A. Domestic Hot Water System

1. Water Heaters & Storage Tanks
2. Hot Water Piping and Insulation
3. Hot Water Mixing Valves and Recirculation Systems
4. Cold Water Distribution Systems
5. Overall DHW System Functionality
6. Plumbing Fixtures
   a. Lavatories
   b. Water Closets
   c. Showers
   d. Urinals
   e. Sinks
   f. Other plumbing fixtures

B. No Functional Testing shall commence until all Prefunctional Checklists are completed and returned to the CxA.

1.9 RECORD DRAWINGS

A. Record drawings shall be kept on the job site and up dated continuously by the Contractor as the work progresses

B. Record drawings shall show exact locations and sizes of all the work to be concealed. Especially note the location of the valves, volume dampers, fire dampers, etc.

C. Non-availability of the updated record drawings or inaccuracies therein shall be grounds for cancellation and/or postponement of any final verification by the Engineer.

1.9 COMMISSIONING APPROACH

A. General

1. The commissioning approach shall include a series of checks, tests, and operational procedures, applied in specific sequences, to each system or equipment component to be commissioned.

2. The contractor shall perform startup tests in accordance with manufacturer's requirements and pre-functional testing in accordance with Commissioning Authority supplied checklists utilizing members of the construction staff and representatives of the equipment and system manufacturer's who are fully knowledgeable of the equipment and systems installation and operation.

3. The plumbing contractor is required to fill out the pre-functional testing forms provided by the Commissioning Agent. The Commissioning agent may observe certain pre-functional tests and their discretion.

4. The specific commissioning procedures required are described in the Project Commissioning plan. These procedures shall be performed in a specific sequence as described in the Project Commissioning Plan. The sequenced application of the procedures is intended to provide a step-wise development, proceeding from the individual component level, to the system level, and ultimately to the multiple integrated level of system operation. This sequencing approach will require certain procedures to be performed earlier in the construction process than for non-commissioned construction, and is intended to help ensure that the installation is free of defects at the earliest opportunity, allowing increased time for correction or modification if defects or performance issues are found.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. Plumbing subcontractor shall furnish all the equipment and labor to perform the systems and equipment installed under their section.

B. Stand-alone datalogging equipment shall be provided by the CxA as needed.

C. BMS tied datalogging equipment and software can be used for Cx as the discretion of the CxA and shall become the property of the Owner.

D. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications. All equipment shall be calibrated according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates readily available where applicable.

E. Refer to the Cx Plan for details regarding equipment that may be required to simulate required test conditions.

PART 3 - EXECUTION

3.1 SUBMITTALS

A. Contractors shall provide submittal documentation for systems to be commissioned indicated herein and in the Cx Plan.

B. Plumbing Contractor shall provide documentation that that includes results of static testing as required by all Division 22 specifications.

C. Plumbing Contractor shall provide all manufacturer-based pre-startup, startup and other equipment specific pre-testing documentation.

D. Contractor shall provide populated prefunctional checklists.

3.2 PRE-COMMISSIONING WORK SESSION & KICKOFF MEETING

A. The Plumbing subcontractor shall participate in the pre-commissioning work session to review the CxA's developing Commissioning Plan. The work session shall be held prior to Plumbing Rough In.

B. The work session shall be held at the General Contractor's principle place of business or at the job site. The GC, CxA, appropriate subcontractors and representatives of the owner shall be scheduled for attendance as a minimum. Subcontractor representatives of the principle trades involved in the commissioning process should also be in attendance and may be scheduled for attendance at the discretion of the CxM.

C. The GC shall record participant comments and distribute minutes of the meeting to all parties involved.

D. The GC shall schedule and chair a commissioning kickoff meeting review the CxA's testing protocols, revisit the commissioning plan and review scheduling for upcoming testing. The work session shall be prior to piping pressure testing.

E. The GC shall schedule and the appropriate subcontractors shall participate in the kickoff meeting held separately from the work session.

F. Plumbing contractor(s) shall participate in both the work session and kickoff meeting.

3.3 STARTUP

A. The plumbing contractor(s) shall follow the start-up and initial checkout procedures listed in the Responsibilities list in this section and in the Cx Plan. Division 22 has start-up responsibility and is required to complete systems and subsystems so they are fully functional, meeting the design objectives of the Contract Documents and manufacturer requirements. The Cx procedures and prefunctional and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the CxA, GC or Owner. Startup shall be conducted by qualified personnel provided by the installing contractor.

3.4 PRE-FUNCTIONAL TESTING

A. Prior to the beginning of the construction phase commissioning and testing specified under this section, the plumbing subcontractor adjust and check operation and performance of the systems and equipment installed under their respective sections.

B. At the discretion of the CxA the sub systems may be required to be tested prior completion of the entire system. This particularly applies to hydronic systems pressure testing.

C. Submit to the CxA all the testing logs.

D. Without limiting the following work shall be performed:

1. Verify and document that the systems and equipment are installed and functioning in accordance with the OPR and contract documents. The as-built drawings and operating manuals reflect the as built conditions.

2. The systems shall be started and their performance shall be checked and compared with the manufacturers requirements as well as design documents.

3. Blank Pre-functional checklists shall be provided by the CxA.

4. Any system or equipment which is does not pass manufacturer startup requirements and Pre-functional testing shall be repaired and replaced at no cost to the owner. The contractor shall retest the system at their own cost until the manufacturers startup requirements and pre-functional testing criteria are met.

3.5 FUNCTIONAL TESTING

A. After review and acceptance of the manufacturer startup forms and pre-functional checklists, the CxA will schedule dates to begin functional testing.

B. Functional testing is intended to begin upon completion of a system installation, startup and pre-functional testing. Functional testing may proceed prior to the completion of systems or sub-systems at the discretion of the CxA and Owner. Beginning system testing before full completion does not relieve the Contractor from fully completing the system, including all PFTs as soon as possible.

C. Procedure Acceptance

1. On-Site Conditional Acceptance

2. Upon satisfactory completion of each commissioning procedure and completion of the procedure close-out meeting, the CxA shall provide conditional acceptance of the procedure.

3. Conditional acceptance shall indicate that the related installation work checked by the procedure and the related performance verified by the procedure is satisfactory, and that the required procedure has been completed, only.

4. Conditional acceptance shall not imply that the equipment and systems involved with the procedure are fully approved and have been provided with final acceptance. Conditional acceptance shall additionally be subject to all notes and comments included in the field notes or test forms, and subject to the satisfactory demonstration that all associated pre-testing, special testing, special testing reports, or alignment reports have been fully completed.

5. Conditional acceptance shall be indicated by the signature of the CxA on the functional testing form.

D. On-Site Procedure Rejection

1. The CxA shall have the authority to reject a procedure in its entirety or to cause the procedure to be stopped if in the opinion of the CxA, any of the following conditions exist:

    a. The pre-procedure review meeting is incomplete.

    b. Appropriate or sufficient contractor staff is not available or required commissioning representatives are not present.

    c. Required pre-testing or report data, such as point-to-point control verifications, alignment reports, and trend log data is not available or is incomplete.

    d. The installation is insufficient or incomplete as required for the procedure or not in compliance with the Contract Documents.

    e. Numerous checks or tests fail or cannot be accomplished.

    f. Installation and/or operation of equipment or systems beyond or in advance of the commissioning requirements.

    g. Installation, operation, or commissioning not in compliance with the sequencing requirements.

    h. Indication of improper maintenance or operation.

    i. Inadequate instrumentation

2. The CxA shall additionally reject a procedure and require the equipment operation or procedure to be stopped if in the opinion of the CxA unsafe conditions to either staff or equipment exist. Consideration of safety issues by the CxA shall not in any way relieve the Contractor from his sole responsibility for job site safety and protection of the equipment.

3. Direction to stop the procedure or halt the operation of equipment will be given verbally. Upon notification the Contractor shall immediately stop the procedure and restore the system or equipment to a safe condition.

4. At the discretion of the CxA, the Contractor may be afforded the opportunity to correct the conditions indicated by the CxA and resume the procedure.

5. If in the opinion of the CxA corrections cannot be implemented in a satisfactory manner, within the scheduled time available for the procedure and with sufficient time available to complete the procedure, the procedure shall be stopped and rescheduled by the CxM. The CxA shall provide the CxM with written notification of procedure rejection stating the cause of the action.

6. The Contractor shall be liable for all actual costs associated with the required attendance by the CxA, the Owner's and A/E's commissioning rep-

resentatives, and required outside agents, resulting from rejected procedure.

7. Actual costs shall include:

   a. Cost for the CxA and for each Owner's and A/E's commissioning representative, which are comprised of contractual billing rate as defined in the respective organization's agreement for such work, including overhead and profit. For CxA and A/E's commissioning representatives, these rates may be found in the A/E schedule for additional services.

   b. Travel-related expenses for the CxA and for each Owner's or A/E's commissioning representative, where such staff is required to be in attendance and not headquartered within the city limits, which are comprised of compensation for actual travel time, with an established minimum of 5 hours, and mileage rates, billed at the prevailing national government rate.

   c. Costs assessed for required outside agents, contractors, or specialists employed by the Owner or A/E at the actual contractual billing rates as defined in the respective organization's agreement for such work.

   d. Equipment rentals, special tools, and related material fees associated with the participation of contracted outside organizations and specialists.

8. The costs assessed will be documented by the CxA and will be deducted from the Contractor's fees or progress payments at the time of occurrence.

3.6 FINAL ACCEPTANCE

A. Final acceptance will be contingent upon satisfactory completion of all commissioning tasks and submittals, with final review and approval by the Commissioning Authority.

B. Where specific components, equipment, or system elements are unable to comply with the specified requirements due to improper or incomplete installation, product defect, or failure of a device to perform to the manufacturer’s published or advertised capabilities, final acceptance will be contingent on repair, replacement, and correction of the deficiencies by the Contractor and satisfactory completion of the commissioning procedures.

C. Where specific components, equipment, or system elements are demonstrated to comply with the specified requirements and perform to the manufacturer’s published or advertised capabilities, but are demonstrated not to provide the performance as required by the Contract Documents and the commissioning procedures, disposition of the issue and/or related modifications shall be provided as directed by the Architect. Final acceptance shall be contingent on the completion of any resulting correction work and related commissioning requirements determined as necessary in final disposition of the issue.

D. Upon satisfactory completion of all commissioning work and resolution of all related issues, the CxA shall provide the Owner, Contractor, and the Architect with a final report documenting recommendation for final acceptance. Recommendation for final acceptance by the CxA shall indicate that in the opinion of the CxA, and as demonstrated within the extent and scope of the commissioning process, the equipment and systems have been installed in compliance with, and function as required by the Contract Documents.

E. The Owner may accept the recommendation of the CxA and provide final acceptance by providing the appropriate authorized signature and by providing copies of the signed acceptance to all parties involved. The Owner's final acceptance of the commissioning work shall indicate that Owner accepts that the systems and equipment, as demonstrated within the extent and scope of the commissioning process, have been installed in compliance with, and function as required by, the Contract Documents. The Owner's acceptance shall not constitute agreement that all contractual obligations are fulfilled and does not constitute final acceptance of the project under the terms and conditions of the Contract Documents.

END OF SECTION

SECTION 22 10 00

PLUMBING PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Sanitary Sewer and Vent Piping, Buried

B. Sanitary Sewer and Vent Piping, Above Grade

C. Storm Water Piping (Roof and Overflow Drainage), Above Grade

D. Storm Water Piping (Roof and Overflow Drainage), Buried

E. Natural Gas Piping, Above Grade

F. Natural Gas Piping, Buried

G. Indirect Waste and Cooling Coil Condensate Piping

H. Flanges, Unions, and Couplings

I. Domestic and Non-Potable Water Piping, Above Grade

J. Domestic and Non-Potable Water Piping, Buried

1.2 RELATED SECTIONS

A. Section 22 05 00 – Common Work Results for Plumbing

B. Section 22 05 04 – Plumbing Specialties

C. Section 22 05 29 – Hanger and Supports for Plumbing Piping and Equipment

D. Section 22 05 48 – Vibration Isolation

E. Section 22 05 53 – Identification for Plumbing Piping and Equipment

F. Section 22 07 00 – Plumbing Insulation

1.3 REFERENCES

A. General
1. ASME B31.1 - Power Piping
2. ASME B31.9 - Building Service Piping
3. ASME SEC IX - Welding and Brazing Qualifications

4. ASTM E814 - Fire Tests of Through-Penetration Fire Stops
5. ASTM F708 - Design and Installation of Rigid Pipe Hangers
6. AWWA C651 - Disinfecting Water Mains
7. MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacturer
8. MSS SP69 - Pipe Hangers and Supports - Selection and Application
9. MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices
10. NCPWB - Procedure Specifications for Pipe Welding
11. UL 1479 - Fire Tests of Through-Penetration Firestops

B. ABS Piping
1. ASTM D2235 - Solvent Cement for Acrylonitrile - Butadiene - Styrene (ABS) Plastic Pipe and Fittings
2. ASTM D2661 - Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings
3. ASTM D2751 - Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings
4. ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe

C. Cast Iron Pipe and Fittings
1. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250 and 800
2. ASME B16.4 - Cast Iron Threaded Fittings Class 125 and 250
3. ASTM A74 - Cast Iron Soil Pipe and Fittings
4. ASTM C564 - Rubber Gaskets for Cast Iron Soil Pipe and Fittings
5. CISPI 301 - Cast Iron Soil Pipe and Fittings for Hubless Cast Iron Sanitary Systems
6. CISPI 310 - Joints for Hubless Cast Iron Sanitary Systems

D. Copper Piping
1. ASME B16.22 - Wrought Copper and Bronze Solder Joint Pressure Fittings
2. ASTM B32 - Solder Metal; AWS A5.8 - Brazing Filler Metal
3. ASTM B75 (ASTM B75M) - Seamless Copper Tube
4. ASTM B88 (ASTM B88M) - Seamless Copper Water Tube
5. AWS A5.8 - Brazing Filler Metal
6. ASME B16.51 – Copper and Copper Alloy Press-Connect Pressure Fittings
7. ASTM F3226 – Standard Specification for Metallic Press-Connect Fittings for Piping and Tubing Systems
8. IAPMO PS 117 – Standard for Press Connections

E. Natural Gas Piping
1. ASME B31.2 - Fuel Gas Piping; NFPA 54 - National Fuel Gas Code
2. ASTM D2513 - Thermoplastic Gas Pressure Pipe, Tubing and Fittings
3. NFPA 54 - National Fuel Gas Code

F. Ductile Iron Piping
1. ASME B16.3 – Malleable Iron Threaded Fittings
2. AWWA C105 - Polyethylene Encasement for Ductile Iron Piping for Water and Other Liquids
3. AWWA C110 - Ductile - Iron and Gray - Iron Fittings 3 inches through 48 inches, for Water and Other Liquids
4. AWWA C111 - Rubber-Gasket Joints for Ductile Iron and Gray-Iron Pressure Pipe and Fittings
5. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids

G. PVC Piping
1. ASTM D2564 - Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings
2. ASTM D2665 - Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
3. ASTM D2729 - Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
4. ASTM D2855 - Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings
5. ASTM D3034 - Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
6. ASTM F437 - Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
7. ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe
8. ASTM F679 - Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
9. AWWA C900 Polyvinyl Chloride (PVC) Pressure Pipe, 4 inches Through 12 inches for Water Distribution

H. Steel Piping
1. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless
2. ASTM A234/A234M - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures

1.4 SUBMITTALS FOR REVIEW

A. Submit under provisions of Section 22 05 00.

B. Product Data: Provide data on pipe materials, pipe fittings, and accessories. Provide manufacturers catalog information. Indicate ratings.

C. Press fittings where used on Division 22 systems shall be by a single manufacturer.

1.5 QUALITY ASSURANCE/QUALITY CONTROL

A. Welding Materials and Procedures: Conform to ASME SEC IX and applicable state regulations.

B. Welders Certification: In accordance with ASME SEC IX.

C. Installers of press-connect copper fittings:
1. Installers shall attend a manufacturer’s installation training class as having been trained and qualified to join piping with press-connect fittings. On-site training and credentialing by the manufacturer’s representative is acceptable.
2. Provide certificate demonstrating that training has been completed for every person installing or crimping fittings by the press fitting manufacturer prior to commencing install to the Owner’s representative.
3. Installer shall be qualified installer, licensed within the jurisdiction, and familiar with the installation of press-connect copper fittings.
4. Press-connect copper fittings shall be installed using proper tool, actuator, jaws, and rings as instructed by the manufacturer.

1.6 REGULATORY REQUIREMENTS

A. Coordinate and comply with serving utility company requirements.

B. Installation and materials of underground pipe, including service piping, if required, shall be as directed by serving utility company.

C. Include applicable utility company charges - See Section 22 05 00.

D. All piping, fittings, valves, fixtures, faucets and equipment containing or conveying potable water shall comply with the latest US Safe Drinking Water Act mandating any wetted surface of the above mentioned items shall not contain above 0.25% lead content by weighted average. All piping, fittings, valve and equipment containing or conveying potable water shall comply with NSF 61 G and NSF 372 or shall be provided with indication on submittals the manufacturer's declaration of self-certification.

1.7 TESTING

A. Sanitary Sewer, Vent, and Storm Water Piping
1. Test all building sanitary sewer, vent and storm water (Roof Drainage/Site Drainage) piping to ensure system is water tight.
2. Drainage piping shall be tested to the point of connection to mains outside the building.
3. Water test: The water test shall be applied to the drainage and vent systems either in its entirety or in sections. If applied to the entire system, all openings in the piping shall be tightly closed, except the highest opening, and the system filled with water to point of overflow. If the system is tested in sections, each opening shall be tightly plugged except the highest opening of the section under test, and each section shall be filled with water, but no section shall be tested with less than a 10 foot head of water. In testing successive sections, at least the upper 10 feet of the next preceding section shall be tested, so that no joint or pipe in the building (except the uppermost 10 feet of the system shall have been submitted to a test of less than 10 feet heat of water. The water shall be kept in the system, or in the portion under test, for at least fifteen minutes before inspection starts. The system shall then be tight at all points. Tests shall be made in the presence of the Owner's Representative.

B. Water Piping
1. Upon completion of a section or of the entire hot and cold water supply system, it shall be tested and proved tight under a water pressure not less than the working pressure under which it is to be used or 100 psig whichever is greater. The water used for tests shall be obtained from a potable source of supply. A fifty (50) pound per square inch air pressure may be substituted for the water test. In either method of test, the piping shall withstand the test without leaking for a period of not less than thirty (30) minutes. Tests shall be made in the presence of the Owner's Representative. Test water piping to connection point at main outside the building.
2. Press fitting piping test:
   a. Special attention shall be given to the required two-step pressure test:
      1) Initial smart connect test for unpressed fitting detection per manufacturer's installation manual.

2) Following a successful smart connect test, the system may be pressure tested up as outlined above. Pressure test not to exceed 600 psi maximum hydrostatic (water) and 200 psi maximum pneumatic (air).

C. Natural Gas Piping
1. Gas piping shall be tested and made tight in accordance with the latest edition of the International Fuel Gas Code and any other governing local gas codes.

D. Records
1. Provide record of pipe tests in accordance with Section 22 05 00.
2. Include certificate of Tests in O&M Manual.
3. Include certificate of Health Department approval of domestic water quality in O&M Manual.

1.8 DELIVERY, STORAGE, AND HANDLING (REFER TO SECTION 22 05 00)

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary protective coating on cast iron and steel valves.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.9 WARRANTY

A. Project Warranty: Refer to Conditions of the Contract for project warranty provisions.

B. Manufacturer’s Warranty: Copper press fittings shall be provided with a 50-year warranty for failure caused by a manufacturing defect.

1.10 DRAWING SCHEDULES

A. Refer to schedules on drawings for model numbers, symbols, etc. for additional information concerning products specified in this section.

PART 2 - PRODUCTS

2.1 SANITARY SEWER AND VENT PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Schedule 40 DWV PVC Pipe: ASTM D2665 or ASTM D3034
1. Fittings: PVC
2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement
3. Hollow core and cellular core pipe and fittings are not allowed.

2.2 SANITARY SEWER AND VENT PIPING, ABOVE GRADE

A. Cast Iron Pipe: ASTM A74, service weight
   1. Fittings: Cast iron
   2. Joints: ASTM C564, neoprene gasket system or lead and oakum

B. Cast Iron Pipe: CISPI 301, hubless, service weight
   1. Fittings: Cast iron
   2. Joints: CISPI 310, neoprene gaskets and stainless steel clamp-and-shield assemblies

C. PVC Pipe: ASTM D2729 or ASTM D2665
   1. Fittings: PVC
   2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement
   3. Hollow core and cellular core pipe and fittings are not allowed.

D. No-hub couplings
   1. Approved Manufacturers (refer to Section 22 05 00):
      a. Husky HD 2000
      b. Clam-All Hi Torque 80
      c. Fernco
   2. Materials: The worm gear drive clamps shall have a hexagon head to accept a 5/16 inch socketed torque wrench. The gaskets shall be manufactured using neoprene rubber meeting the requirements of ASTM C-564. Sealing rings shall be molded into the gasket and positioned under each torquing band. Couplings shall meet the performance requirements of coupling standard FM 1680 class 1.
   3. Corrugated Couplings
      a. Shield constructed of 304 corrugated stainless steel with a minimum thickness of 0.010”.
      b. Coupling pipe sizes 1 ¼” through 4” shall have 4 bands.
      c. Couplings for pipe sizes 5” through 10” shall have 6 bands.

2.3 WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Copper Tubing: ASTM B42, hard drawn, Type K
   1. Fittings: ASME B16.22 wrought copper, cast copper, brass
   2. Joints: AWS A5.8, BCuP silver braze
      a. Exception: Trap primer piping below slab may be continuous lengths of soft copper or PEX-A piping provided piping has not joints under the slab.
   3. Wrap for Underground Piping: Calpico Inc. pipe wrapping polyvinyl tape, 20 mil thickness, with identification per IAPMO.

B. Copper Tubing: ASTM B42, annealed, Type K
   1. Fittings: none
   2. Joints: none

C. Ductile Iron Pipe: AWWA C151
   1. Fittings: AWWA C110, Ductile iron, standard thickness
   2. Joints: AWWA C111, rubber gasket with ¾ inch diameter rods

2.4 WATER PIPING, ABOVE GRADE (COPPER)

A. This includes domestic/potable, non-potable and make-up water.

B. Grooved fittings are strictly prohibited.

C. Piping smaller than 2”
1. Copper Tubing: ASTM B88, Type L, hard drawn
2. Fittings: ASME B16.22, wrought copper, cast copper, brass.
   a. Extruded tee connections not allowed
3. Joints: ASTM B32, solder, Grade 95TA, lead-free.
4. Press Fittings: Viega ProPress copper fittings, or approved equal, may be utilized in lieu of solder joints on sizes below 2” only; EPDM sealing element; ASME B16.51, ASME B88, ASME F3226, IAPMO PS 117, NSF-61-372; max operating pressure of 300 PSI, test pressure of 600 PSI, and operating range of 0°F to 250°F.

D. Piping 2” and above
1. Copper Tubing: ASTM B88, Type L, hard drawn
2. Fittings: ASME B16.22, wrought copper, cast copper, brass.
   a. Extruded tee connections not allowed
3. Joints: AWS A5.8, BCuP silver braze, lead-free.
4. Piping 2” and above shall be brazed, and shall not utilize solder or press fittings.

2.5 STORM WATER PIPING, (ROOF DRAINAGE; RDL AND ODL) BURIED WITHIN 5 FEET OF BUILDING

A. Schedule 40 DWV PVC Pipe: ASTM D2665
1. Fittings: PVC
2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement
3. Hollow core and cellular core pipe and fittings are not allowed.

2.6 STORM WATER PIPING, (ROOF DRAINAGE; RDL AND ODL) ABOVE GRADE

A. Cast Iron Pipe: ASTM A74 service weight
1. Fittings: Cast iron
2. Joints: ASTM C564, neoprene gasket system

B. Cast Iron Pipe: CISPI 301, hubless, service weight
1. Fittings: Cast iron
2. Joints: CISPI 310, Neoprene gaskets and stainless steel clamp-and-shield assemblies

C. No-hub couplings
1. Approved Manufacturers (refer to Section 22 05 00):
   a. Husky HD 4000
   b. Clam-All Hi Torque 80
   c. Fernco
2. Materials: The worm gear drive clamps shall have a hexagon head to accept a 5/16 inch socketed torque wrench. The gaskets shall be manufactured using neoprene

rubber meeting the requirements of ASTM C-564. Sealing rings shall be molded into the gasket and positioned under each torquing band. Couplings shall meet the performance requirements of coupling standard FM 1680 class 1.

3. Corrugated Couplings
   a. Shield constructed of 304 corrugated stainless steel with a minimum thickness of 0.0151".
   b. Coupling pipe sizes 1 ¼" through 4" shall have 4 bands.
   c. Couplings for pipe sizes 5" through 10" shall have 6 bands.

2.7 NATURAL GAS PIPING, BURIED-DOWNSTREAM OF METER/REGULATOR SET

A. Steel Pipe: ASTM A52 Schedule 40 black, Type E or S, Grade B, seamless, beveled ends, butt welded.
   1. Fittings: ASTM A234/A234M, forged steel welding type
   2. Joints: ASME B31.2, welded
   3. Jacket: AWWA C105 polyethylene jacket or double layer, half-lapped 10 mil polyethylene tape

B. Polyethylene Pipe: ASTM D-2513, Category 1
   1. Fittings: ASTM D-2513 Polyethylene (PE), stab type fittings, including anodeless gas risers
   2. Tracer Wire: Provide entire length of underground gas piping with anodes in strict conformance with manufacturers recommendations.
   3. Gas Risers: Anodeless, SDR-10 and or SDR-11
   4. Manufacturer: Gastite or approved equal

2.8 NATURAL GAS PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53 Schedule 40 black, Type E or S, Grade B, seamless, beveled ends.
   1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M, forged steel welding type
   2. Joints: NFPA 54, threaded or welded to ANSI B31.2, ANSI B31.9, ASME Sec 1.

2.9 INDIRECT WASTE AND COOLING COIL CONDENSATE DRAIN PIPING:

A. Type M copper tubing with soldered Joints. Min. size ¾"

2.10 FLANGES, UNIONS, AND COUPLINGS

A. Pipe Size 2 inches and under:
   1. Ferrous pipe: Class 150 malleable iron threaded unions
   2. Copper tube and pipe: Class 150 bronze unions with soldered joints

B. Pipe Size over 2 inches:
   1. Ferrous pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets

2. Copper tube and pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets

2.11 DIELECTRIC PIPE FITTINGS:

A. Dielectric Unions: Factory-fabricated, union assembly for 250 psig minimum working pressure at a 180°F temperature.
1. Manufacturers: Epco Sales, Inc.; Watts Industries, Inc. – Water Products Division or Zurn Industries, Inc. – Wilkins Division.

B. Dielectric Flanges: Factory-fabricated, companion-flange assembly for 150- or 300-psig minimum pressure to suit system pressures.
1. Manufacturers: Epco Sales, Inc. or Watts Industries, Inc. – Water Product Division.

C. Dielectric-Flange Insulation Kits: Field-assembled, companion-flange assembly, full-face or ring type. Components include neoprene or Phenolic gasket, Phenolic or polyethylene bolt sleeves, Phenolic washers, and steel backing washers.
1. Provide separate companion flanges and steel bolts and nuts for 150- or 300-psig minimum working pressure to suit system pressures.
2. Manufacturers: Advance Products & Systems, Inc.; Calipco, Inc. or Pipeline Seal and Insulator, Inc.

D. Dielectric Couplings: Galvanized-Steel coupling, having inert and noncorrosive, thermoplastic lining, with threaded ends and 300-psig minimum working pressure at 225°F temperature.
1. Manufacturers: Calpico, Inc. or Lochinvar Corp.

E. Dielectric Nipples: Electroplated steel nipple, having inert and non-corrosive thermoplastic lining, with combination of plain, threaded, or grooved end types and 300-psig working pressure at 225°F temperature. Nipples shall be listed by IAPMO/UPC and SBCCI PST and ESI.
1. Manufacturers: Precision Plumbing Products, Inc.; Sioux Chief Manufacturing Co., Inc.; Perfection Corp. or Victaulic Co. of America.

PART 3 - EXECUTION

3.1 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION – GENERAL

A. All roof drain and overflow drain piping shall be cast iron. Do not utilize PVC piping for RDL/ODL applications.

B. PVC piping shall be used in all below and above grade sanitary sewer and vent piping applications, with the exception of Area A. In Area A, only cast-iron piping shall be used for above grade waste and vent piping. In Area B and Area C, only PVC piping shall be used for above grade waste and vent. Cast-iron shall not be used for above grade waste and vent in Area B and Area C.

C. Provide pipe in accordance with manufacturer's instructions and as indicated on the drawings.

D. Install all exposed PVC piping in a clean manner. Do not allow colored primer or solvent weld cement to be seen in exposed applications. Install PVC piping such that any lettering or printing on the exterior of the pipe is turned up towards the structure, so it is not visible from the floor.

E. Install valves in piping system in accordance with Section 22 05 03 and as indicated on plans.

F. Provide non-conducting dielectric connections wherever jointing dissimilar metals. Dry Piping Systems (Gas, Compressed air, and vacuum): Install dielectric unions and flanges. Wet Piping Systems (water): Install dielectric coupling and nipple ftg.

G. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls. Install piping without sags or bonds.

H. Allow for sufficient space above removable ceiling panels to allow for ceiling panel removal.

I. Provide piping and all required offsets and fittings in order to coordinate with other trades, minimize structural interferences, conserve space and maintain headroom. Refer to Section 22 05 00 Common Work Results for Plumbing Piping.

J. Group piping whenever practical at common elevations.

K. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 22 05 16.

L. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 22 07 00.

M. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

N. Provide support for utility meters in accordance with requirements of utility companies.

O. Prepare exposed, ferrous metals (unfinished pipe, fittings, supports, and accessories) ready for finish painting. Refer to Division 9.

P. Excavate and backfill in accordance with Section 22 05 00.

Q. When making transitions from below grade to above grade pipe materials, make transitions between materials within 8" of the finished floor slab.

R. Install bell and spigot pipe with bell end upstream.

S. Install valves with stems upright or horizontal, not inverted.

T. Provide supports, hangers, insulation shields, sleeves, escutcheons, and inserts in accordance with Section 22 05 29 and 22 05 17.

U. Provide flexible pipe connections at exterior building wall.

V. Provide pipe wrap for all copper pipe installed below ground.

W. Pipe Insulation thru Concrete.
1. General: Provide a minimum 1-inch thick pipe insulation for all copper pipe installed through concrete, footings, grade beams, etc.
2. Cleaning: Remove loose scale, rust, dirt, oil and grease before wrapping.
3. IMOC, IMCOSHIELD, non-slit pre-lubricated polymer foam insulation. H.

X. Provide proper firestop protection of PVC piping penetrations of fire-resistant-rated walls, shafts, or floor-ceiling assemblies.

Y. Hubless Piping: Clamps shall be tightened to 80 inch pound and installed in accordance with the manufacturers requirements.

Z. Connect branch piping to top of mains.

AA. Combination double wye and 1/8th bend fittings are only allowed for vertical drainage. For horizontal drainage, double wye DWV fittings are allowed if separate 1/8th bend fittings are used for the branches.

BB. Condensate piping for and cooling coils
1. Provide at all equipment connections.
2. Slope a minimum of 1% to drain.
3. Pipe size shall not be less than ¾” and shall not be less than the equipment outlet size.
4. Provide traps as required by the equipment or appliance manufacturer and/or as detailed on drawings.
5. Ductless split systems shall be provided with a in-line check valve in the drain line or a trap.
6. Condensate piping shall be configured to permit the cleaning of blockages and perform maintenance without requiring the drainline to be cut.

3.3 INSTALLATION – PRESS FITTINGS

A. Every person on-site installing or crimping press fittings must attend the press fitting manufacturer’s approved installation training class prior to commencing install, per Part 1 of this specification.

B. Press fittings to be installed in strict accordance with the manufacturer's requirements.
1. Join piping and press-connect fittings with tools recommended by fitting manufacturer.
2. All connections shall bear full insertion marks on the pipe.

3. Special attention shall be given to the required two-step pressure test outlined in Part 1 of this specification.

C. Minimum distance between press pipe fittings shall be 4 times the pipe diameter.

3.4 COPPER PIPE FITTINGS

A. Field fabricated copper fittings not allowed.
   1. Solder fittings not allowed on water hammer arrestors.
   2. Copper female adapters not allowed on fan coil connections. Use male adapter with brass fitting.

3.5 INSTALLATION - GAS PIPE

A. Gas pipe installed underground, through air plenums, in walls, and in inaccessible shafts, and pipes 2½ inches and larger shall have welded fittings and joints. Other pipe may have screwed or welded fittings.

B. Lay underground gas pipe in accordance with local gas utility company regulations, International Fuel Gas Code and specifications. Install warning tape 12" above centerline of buried gas pipe. Tape shall be detectable with magnetic location devices.

C. Underground polyethylene gas pipe fittings are typically not acceptable and will only be allowed at the riser to the gas meter and when pipe length exceeds length of new/un-used roll of pipe.

D. Provide gas stops on lines serving unit heaters, water heaters and other gas fired equipment adjacent to equipment on outside of cabinet and easily accessible.

E. Do not use flexible gas pipe connections to hot water heaters. Utilize flexible gas connections to all other gas fired equipment.

F. Install dirt leg with pipe cap, 6 inches long minimum, on each vertical gas pipe drop to equipment.

G. Gas pressure regulators:
   1. Install in accordance with the manufacturer requirements and drawings.
   2. When installed inside, shall be vented to the outside with full size vent with screened discharge elbowed down. Vent piping shall be sized in accordance with manufacturer’s recommendations and code requirements.
      a. All gas pressure regulator vents shall be routed through the roof. Route gas pressure regulator vents such that the penetration through the roof is centered on the roof panel. The roof is comprised of approximately 8”x8” panels. Refer to the Architectural drawings and specifications for more information on roof type.
   3. Provide a minimum of 10 linear feet of pipe between appliance fuel train inlet and the discharge of the regulator. Provide reducers/increasers to appliance connection at the appliance.

H. Provide accessible main shutoff valve at entrance to building.

I. Refer to Section 22 05 49 and 23 05 49 for seismic bracing requirements for gas piping.

J. Install gas piping in accordance with International Fuel Gas Code.

3.6 APPLICATION

A. Flanges / Unions:
   1. Steel Pipe:
      a. Threaded pipe, 2 inches smaller: Install unions downstream of each valve with screwed joint upstream
      b. Welded pipe, 2 ½ inches and larger: Flanged connections both sides of valve
      c. Use unions at final connection to each piece of equipment or apparatus having a threaded pipe connection.
      d. Use flanges at final connection to each piece of equipment or apparatus having a flanged pipe connection.
   2. Copper Pipe:
      a. Threaded pipe: Install union down stream of each valve with screwed joint up stream. Use brass male adapters each side of valve.
      b. Soldered pipe: No unions required either side of valve.
      c. Use unions at final connection to each piece of equipment or apparatus having a threaded pipe connection.
      d. Use flanges at final connection to each piece of equipment or apparatus having a flanged pipe connection.
   3. Notes to above: Temperature control valves shall have unions and/or flanges at each port. Valves with screwed connections that cannot be rotated shall have unions on each side of valve. Do not use direct welded or threaded connections to valves, equipment or other apparatus.

B. Provide brass male adapters each side of valves in copper piped system. Solder adapters to pipe.

3.7 ERECTION TOLERANCES

A. Establish invert elevations, slopes for drainage to ¼ inch/foot, 2 %, minimum unless indicated otherwise on drawings. Maintain gradients.

B. Install piping so that entire system is drainable. Provide drain valves with hose connections at low points.

3.8 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. Prior to starting work, verify system is complete, flushed and clean.

B. Ensure Ph of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).

C. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.

D. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 % of outlets.

E. Maintain disinfectant in system for twenty-four (24) hours.

F. If final disinfectant residual tests less than 25 mg/L, repeat treatment.

G. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.

H. Take samples no sooner than twenty-four (24) hours after flushing, from 10 % of outlets and from water entry, and analyze in accordance with AWWA C651. Provide laboratory results to Owner's Representative. Obtain approval from local health department.

3.9 SERVICE CONNECTIONS

A. Provide sanitary and storm sewer connections to sewer services outside the building as indicated. Before commencing work check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with slope for drainage and cover to avoid freezing.

B. Provide new water service complete with approved backflow preventer with by-pass valves. Connect to water service outside the building as indicated.

C. Provide new gas service complete with gas meter main shutoff valve and required regulators and bollards for protection.
Coordinate gas utility meter procurement with the utility company

END OF SECTION

SECTION 22 15 00

GENERAL SERVICE COMPRESSED AIR SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Compressed air system

B. Coordinate with compressed air systems vendor to assure that rough-in and wiring provisions are complete in every detail.

C. Schedule rough-in and wiring work to allow sufficient time prior to project completion for installation and testing of compressed air systems equipment and devices. The Contractor shall cooperate with said vendor to facilitate completion of all related work concurrent with the remainder of the construction work.

1.2 RELATED SECTIONS

A. Section 22 05 00 – Common Work Results for Plumbing

B. Section 22 05 13 – Common Motor Requirements for Plumbing Equipment

C. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment

D. Section 22 05 48 – Vibration Isolation

E. Section 22 05 53 – Identification for Plumbing Piping and Equipment

1.3 REFERENCES

A. ANSI B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings

B. ANSI B40.1 - Gauges, Pressure and Vacuum, Indicating Dial Type-Elastic Element

C. ASME Boiler and Pressure Vessel Code

D. ASTM B-88 Copper compressed air Gas Tube

E. ASTM B32 - Solder Metal

F. AWS B2.2 - Standard for Brazing Procedure and Performance Qualifications

G. ASTM B828 - Making Capillary, Joints by Soldering of Copper and Copper Alloy Tube and Fittings

H. AWS A5.8 - Brazing Filler Metal

I. FS WW-V-35 - Valve Ball

J. FS WW-V-54 - Valve, Gate, Bronze (125, 150 and 200 Pound, Screwed, Flanged, Solder End, for Land Use)

K. MIL-V-82026 - Valves, Diaphragm, Stop

L. MSS SP-58 - Pipe Hangers and Supports - Selection and Application

M. MSS SP-73 - Brazing Joints for Wrought and Cast Copper Alloy Solder Joint Pressure Fittings

N. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves

O. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

P. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)

1.4 SUBMITTALS FOR REVIEW

A. Submit under provisions of Section 22 05 00.

B. Product Data:
1. Provide manufacturers literature and illustrations for all components indicating size, dimensions and configuration.

C. Shop Drawings:
1. Indicate general assembly of components, mounting and installation details, and general layout of control panels.

1.5 SUBMITTALS AT PROJECT CLOSEOUT (REFER TO SECTION 22 05 00)

A. Operation Data: Include installation instructions, assembly views, lubrication instructions, and assembly views.

B. Maintenance Data: Include maintenance and inspection data, replacement part numbers and availability, and service depot location and telephone number.

1.6 QUALITY ASSURANCE

A. Ensure products and installation of specified products are in conformance with recommendations and requirements of the following organizations:
1. American Society of Mechanical Engineers (ASME)
2. National Electrical Manufacturer’s Association (NEMA)
3. Underwriters Laboratories (UL)

1.7 REGULATORY REQUIREMENTS

A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.8 DELIVERY, STORAGE AND HANDLING (REFER TO SECTION 22 05 00)

A. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

PART 2 - PRODUCTS

2.1 PIPE AND PIPE FITTINGS

A. Compressed Air, Above grade:
1. Copper Tube: ASTM B-819, Type K or L, hard drawn
2. Fittings: ANSI B16.22, wrought copper
3. Joints: AWS A5.8 Classification BCuP series silver braze

2.2 VALVES

A. Manufacturers (Refer to Section 22 05 00):
1. Crane
2. Milwaukee
3. Grinnel
4. Stockham
5. Nibco
6. Watts
7. Mueller

B. Ball Valves:
1. FS WW-V-35 Type II, Class A, Style 1; MSS SP-110; bronze body, three piece, double-seal, full-port, ball valves with replaceable neoprene or Teflon seat and stem seals, for minimum 400 psi or 29 inches HG cold working pressure, flange or union mounting, labeled for intended service

2.3 REGULATORS

A. Manufacturers (Refer to Section 22 05 00):
1. Speedair
2. Wilkerson

B. Regulators:
1. Outlet compressed air system regulator, heavy duty self, re-leaving type with balanced poppet and aspirator. 2 to 125 psi adjustable output. Equal to Speedair “Grainger” Stock No. 6ZC27 with two (2) 1X762 pressure gauges. 1½ inch size regulator.

2.4 PIPING ACCESSORIES

A. Hangers and Supports (see Section 22 05 29):

B. Flexible Connectors: Corrugated flexible, single ply, seamless or seam-welded tubing of stainless steel or bronze or reinforced teflon bellows or hose.

C. Piping Identification: Section 22 05 53.

2.5 POINT OF USE NON-CYCLING REFRIGERATED DRYER

A. Manufacturers (Refer to Section 22 05 00):
1. Champion

B. Refer to schedule on the drawings for model numbers, size, capacities, and accessories.
1. Rated for 64 scfm at 100 psi and 100°F ambient temperature, maximum pressure drop at 20 scfm shall be 1.5 psi. Rated for a maximum working pressure of 250 psi.
2. Fully hermetic compressors
3. Microprocessor control

2.6 PROVIDE WITH AUTOMATIC DRAIN VALVE WITH INDIRECT PIPING TO FLOOR DRAIN.AIR COMPRESSORS

A. Manufacturers (Refer to Section 22 05 00):
1. Champion

B. Refer to schedule on the drawings for model numbers, size, capacities, and accessories.

C. Type: Reciprocating packaged with integral dryer, 240 gallon receiver and control panel.

D. Compressors shall be supplied with the following:
1. Integrated air cooled aftercooler, oil cooler and water separator
2. Integrated refrigerated air dryer equal to the maximum capacity of the air compressor, dewpoint 35 to 39 °F
3. Integrated general purpose particulate and coalescing air filters (DD filter 1.0 micron, liquid 0.08 ppm) (PD filter 0.01 micron, liquid 0.008 ppm)
4. Integrated electronic drain on integral air receiver
5. DOL starter, TEFC tri-voltage motor
6. Factory oil fill
7. Receiver (as indicated on drawings)
8. Compressor, dryer, controls, receiver and filters shall be install within factory enclosure with maximum dBA rating of 70
9. Minimum rated capacity of compressor shall be as scheduled on drawings.
10. System pressure shall be regulated to 120 psig or as scheduled on drawings.
11. Electro-Pneumatic capacity control
12. Minimum two (2) year screw element warranty
13. One (1) year package warranty.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Braze joints in pipe and tubing. Avoid leaving excess flux inside of pipe and fittings.

B. Effect changes in size with reducing fittings. Make changes in direction of required turns or offsets with fittings or tubing shaped by bending tools. Make bends free of flattening, buckling or thinning of tube wall.

C. Cut pipe and tubing accurately and install without springing or forcing.

D. Provide pipe sleeves where pipes and tubing pass through walls, floors, roofs, and partitions. Finish flush at both ends. Extend 2 inches above finished floors. Pack space between pipe or tubing and sleeve, and calk.

E. Identify piping with tape and decals. Provide piping identification code and schematic. Refer to Section 22 05 53. Install labeling on pipe at intervals of not more than 20 feet and at least once in each room and each story traversed by pipeline.

F. Except where indicated or in flush wall mounted cabinets, install manual shut off valves with stem vertical and accessible for operation and maintenance.

G. Provide a valved by-pass around receivers.

H. Vibration and Noise Isolation: In accordance with Section 22 05 48.

I. Provide electric motor drive equipment with electrical equipment and wiring.

J. Provide an air “bleed” line at the end of the main piping system to allow the Owner to bleed any water trapped in the piping system. The line shall be terminated 4’ above the finished floor with a normally closed ball valve.

3.2 PIPING SYSTEMS CLEANING AND PRESSURE TESTING

A. After erection of pipe and tubing but prior to installation of service outlet valves, blow systems clear of free moisture and foreign matter with nitrogen gas.

B. Install service outlet valves, subject system to test pressure of 150 psi with nitrogen or dry compressed air. Check with soapy water. Provide twenty-four (24) hour standing pressure test.

3.3 TEST - COMPRESSED AIR SYSTEMS

A. Test system with dry compressed air or dry nitrogen.

B. Check each station outlet of every piping system to determine test gas is dispensed only from outlet of system under investigation. Measure pressure with gauge attached to specific adaptor. Do not use universal adaptors. Perform cross connection test.

C. Disconnect test gas and connect proper gas to each system. Purge entire system to remove test gas. Check with analyzer suitable for gas installed.

3.4 FACTORY AUTHORIZED AND WARRANTED START-UP

A. Contractor shall include factory authorized/warranted start-up for air compressors to conform with the requirements of these contract documents and with manufacturer's recommendations.

B. A certificate from the manufacturer shall be included within the O&M manuals which indicate the start-up of the air compressors has been performed by a qualified and authorized factory representative. The certificate shall also include a statement that all of the specified and factory requirements for fully guaranteed systems have been met.

3.5 TEST - RECORDS

A. The Contractor shall furnish to the Owner two complete sets of system documentation. The documentation shall be furnished in bound volumes. A preliminary copy shall be submitted by the Contractor in accordance with the requirements of Section 22 05 00. The system documentation shall include, but not be limited to, the following:
   1. Wiring diagram
   2. Test results
   3. Warranties

END OF SECTION

SECTION 22 30 00

PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Commercial gas-fired water heaters

B. Water heater seismic straps

C. Diaphragm-type compression tanks

D. Domestic hot water storage tanks

E. In-line circulator pumps

1.2 RELATED SECTIONS

A. Section 22 05 00 – Common Work Results for Plumbing

B. Section 22 05 19 – Meters and Gauges for Plumbing Piping

C. Section 22 05 23 – General Duty Valves for Plumbing Piping

D. Section 22 05 48 – Vibration Isolation

E. Section 22 05 53 – Identification for Plumbing Piping and Equipment

F. Section 22 07 00 – Plumbing Insulation

1.3 REFERENCES

A. ASHRAE 90A - Energy Conservation in New Building Design

B. ASME Section 8D - Pressure Vessels

C. NFPA 30 - Flammable and Combustible Liquids Code

D. NFPA 54 - National Fuel Gas Code

E. NFPA 58 - Storage and Handling of Liquified Petroleum Gases

F. NFPA 70 - National Electrical Code

1.4 SUBMITTALS FOR REVIEW (REFER TO SECTION 22 05 00)

A. Product Data:
1. Provide dimension drawings of water heaters indicating components and connections to other equipment and piping.
2. Indicate pump type, capacity, power requirements.
3. Provide certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.
4. Provide electrical characteristics and connection requirements.

B. Shop Drawings:
1. Indicate equipment dimensions, size of tappings, and performance data.
2. Indicate dimensions of tanks, tank lining methods, anchors, attachments, lifting points, tappings, and drains.

1.5 OPERATION AND MAINTENANCE DATA (REFER TO SECTION 22 05 00)

A. Include operation, maintenance, and inspection data, replacement numbers and availability, and service depot location and telephone number.

1.6 QUALITY ASSURANCE

A. Ensure products and installation of specified products are in conformance with recommendations and requirements of the following organizations: American Gas Association (AGA); National Sanitation Foundation (NSF); American Society of Mechanical Engineers (ASME); National Board of Boiler and Pressure Vessel Inspectors (NBBPVI); National Electrical Manufacturers' Association (NEMA); Underwriters Laboratories (UL); ASHRAE 90-A energy efficiency standards.

B. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, operate within 25 % of midpoint of published maximum efficiency curve.

1.7 REGULATORY REQUIREMENTS

A. Conform to AGA, NSF, UL 174, UL 1453 requirements for water heaters.

B. Conform to ASME Section 8D for manufacture of pressure vessels for heat exchangers.

C. Conform to ASME Section 8D for tanks.

D. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.8 DELIVERY, STORAGE, AND HANDLING (REFER TO SECTION 22 05 00)

A. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.9 REGULATORY REQUIREMENTS

A. All piping, fittings, valves, fixtures, faucets and equipment containing or conveying potable water shall comply with the latest US Safe Drinking Water Act mandating any wetted surface of the above mentioned items shall not contain above 0.25% lead content by weighted average. All piping, fittings, valve and equipment containing or conveying potable water shall comply with NSF 61 G and NSF 372 or shall be provided with indication on submittals the manufacturer's declaration of self-certification.

PART 2 - PRODUCTS

2.1 COMMERCIAL GAS FIRED SELF-CONTAINED WATER HEATERS

A. Manufacturers (Refer to Section 22 05 00):
1. A.O. Smith
2. Lochinvar
3. Ruud
4. Bradford White

B. Refer to schedule on drawings for model numbers, size, capacities and accessories.

C. Type: Automatic, natural gas-fired; vertical storage; sealed combustion and submerged combustion chamber with helical heat exchanger coil.

D. Tank: Glass lined coating, welded steel, multiple flue passages, 4 inch diameter inspection port, thermally insulated with minimum 2 inches glass fiber encased in corrosion-resistant steel jacket; baked-on enamel finish; floor shield and legs. Maximum hydrostatic working pressure: 160 psig. Provide 3 year warranty on storage tank.

E. UL listed, ASHRAE 90.1 compliant.

F. Accessories: Brass water connections and dip tube, drain valve, powered non-sacrificial magnesium anodes, and ASME rated temperature and pressure relief valve.

G. Controls: Integrated solid-state temperature and ignition control with integral diagnostics and automatic water thermostat with temperature range adjustable from 120 °F to 180 °F, automatic reset high temperature limiting thermostat factory set at 180 °F, gas pressure regulator, multi-ribbon or tubular burner, 100 % safety shut-off pilot and thermocouple, flue baffle and draft hood.

H. Minimum thermal efficiency 94%.

2.2 WATER HEATER SEISMIC STRAPS

A. General:
1. Water heaters shall be anchored or strapped to resist horizontal displacement due to earthquake motion. Strappings shall be at points within the upper one-third and lower one-third of its vertical dimensions. At the lower point, a distance of not less than four (4) inches (102 mm) shall be maintained from the controls to the strapping.

B. For tanks up to 120 gallons:
   1. Manufacturers (refer to Section 22 05 00):
      a. Holdrite
      b. Amber Booth
      c. VMC
   2. Provide a double body strap water heater restraint system for water heaters between 80 and 120 gallons. Seismic/earthquake support system. Includes (4) straps, (4) J-clips, (4) 3/8 in carriage bolts and (2) 3/8 in hex nuts. System allows for full adjustment from the front side of the water heater. Made of 24 ga CRS, galvanized material.

2.3 DIAPHRAGM-TYPE COMPRESSION TANKS

A. Manufacturers (Refer to Section 22 05 00):
   1. Amtrol
   2. Taco
   3. Armstrong

B. Construction: Welded steel; tested and stamped in accordance with Section 8D of ASME Code; supplied with National Board Form U-1; rated for working pressure of 125 psig; with heavy duty butyl rubber diaphragm or bladder; and steel legs or saddles. Full acceptance type with inspection.

C. Accessories: Pressure gauge and air-charging fitting; tank drain; precharge to 12 psig unless indicated otherwise on the drawings.

D. Refer to schedule on drawings for model numbers, size, etc.

2.4 DOMESTIC HOT WATER STORAGE TANKS

A. Manufacturers (Refer to Section 22 05 00):
   1. A.O. Smith
   2. State
   3. Ruud
   4. Bradford White

B. Refer to schedule on drawings for model numbers, size, capacities, accessories.

C. Tank: Welded steel, ASME labeled for working pressure of 125 psig, steel support saddles, tappings for accessories, threaded connections of stainless steel, access manhole.

D. Lining: Corrosion-resistant concrete approximately ¾ inch thick 0.015 inches epoxy 0.024 inches self-priming polymer epoxy, continued into flanged connections.

E. Openings: Up to 3 inches, copper-silicone threaded; over 4 inches, flanged ; flanged collar for heat exchanger ; manway fitting.

F. Accessories: Tank drain, water inlet and outlet, thermometer range of 40 °F to 200 °F, ASME pressure relief valve suitable for maximum working pressure.

G. Tank shall be factory insulated meeting ASHRAE 90.1.

2.5 IN-LINE CIRCULATOR PUMPS

A. Manufacturers (Refer to Section 22 05 00):
1. B&G
2. Taco
3. Grundfos
4. Armstrong

B. Construction: Bronze casing; 125 psig working pressure; replaceable impeller assembly; no mechanical seals.

C. Refer to schedule on drawings for model numbers, size, capacities, accessories.

D. Impeller: Bronze.

E. Shaft: Alloy steel with integral thrust collar and two oil lubricated bronze sleeve bearings.

F. Seal: Carbon rotating against a stationary ceramic seat.

PART 3 - EXECUTION

3.1 INSTALLATION – GENERAL

A. Water heater shall be installed and placed in operation by factory approved mechanic.

B. Install in strict accordance with manufacturer's instructions and as detailed.

C. Provide isolation valves and unions.

D. Pipe relief valve discharge to floor drain or other safe location as indicated.

E. Provide water heaters as indicated, and in accordance with the manufacturer's instructions and to AGA and UL requirements as applicable.

F. Coordinate with plumbing piping and related fuel piping, gas venting and electrical work to achieve operating system.

G. Provide isolation valves and unions at all tanks, heaters, softeners, pumps, booster system.

H. Minimize tripping hazards when installing drain lines.

I. Seismically restrain the water heater. Install fasteners, straps and brackets as required to secure the equipment in accordance with the strap manufacturer instructions.

3.2 DOMESTIC HOT WATER STORAGE TANKS

A. Provide steel pipe support, independent of building structural framing members.

B. Clean and flush after installation. Seal until pipe connections are made.

3.3 PUMPS

A. Provide air cock and drain connection on horizontal pump casings.

B. Provide line sized isolating valve and strainer on suction and line sized soft seated check valve and balancing valve on discharge.

C. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings.

D. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 % of midpoint of published maximum efficiency curve.

3.4 FLOOR MOUNTED EQUIPMENT

A. Install floor mounted equipment on 4 inch concrete housekeeping pads, 6 inch larger on each side than base of unit. Coordinate size and location with Division 03.

3.5 FACTORY AUTHORIZED AND WARRANTED START-UP

A. Contractor shall include factory authorized/warranted start-up for the air compressors and associated controls to conform with the requirements of these contract documents and with manufacturer’s recommendations.

B. A certificate from the manufacturer shall be included within the O&M manuals which indicate the start-up of the air compressors has been performed by a qualified and authorized factory representative. The certificate shall also include a statement that all of the specified and factory requirements for fully guaranteed systems have been met.

END OF SECTION

SECTION 22 40 00

PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Lavatories

B. Water Closets

C. Urinals

D. Floor Mounted Service Sinks

E. Stainless Steel Sinks

F. Electric Water Coolers/Bottle Filling Station

G. Emergency Eye Wash And Drench Hose

H. Emergency Showers And Eyewash Combination Unit

I. Wash fountains

J. Wall Carriers

K. Stops/Supplies & Waste Fittings

L. Protective Shielding Guards

M. Disposers

1.2 RELATED SECTIONS

A. Division 7

B. Section 22 05 00 – Common Work Results for Plumbing

C. Section 22 05 04 – Plumbing Specialties

D. Section 22 05 23 – General Duty Valves for Plumbing Piping

E. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment

F. Section 22 30 00 – Plumbing Equipment

1.3 REFERENCES

A. General
1. ASME A112.6.1 - Supports for Off-the-Floor Plumbing Fixtures for Public Use
2. ASME A112.18.1 - Finished and Rough Brass Plumbing Fixture Fittings
3. ASME A112.19.1 - Enameled Cast Iron Plumbing Fixtures
4. ASME A112.19.2 - Vitreous China Plumbing Fixtures
5. ASME A112.19.4 - Porcelain Enameled Formed Steel Plumbing Fixtures
6. ASME A112.19.5 - Trim for Water-Closet Bowls, Tanks, and Urinals
7. NFPA 70 - National Electrical Code
8. LEED v4.0 - Building Design and Construction

B. Drinking fountains and electric water coolers:
1. ARI 1010 - Drinking Fountains and Self-Contained Mechanically Refrigerated Drinking Water Coolers

C. Emergency eye-wash and showers:
1. ANSI Z358.1 - Emergency Eye Wash and Shower Equipment

1.4 SUBMITTALS FOR REVIEW (REFER TO SECTION 22 05 00)

A. Product Data: Provide catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

1.5 OPERATION AND MAINTENANCE DATA (REFER TO SECTION 22 05 00)

A. Maintenance Data: Include fixture trim exploded view and replacement parts lists.

1.6 REGULATORY REQUIREMENTS

A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

B. All piping, fittings, valves, fixtures, faucets and equipment containing or conveying potable water shall comply with the latest US Safe Drinking Water Act mandating any wetted surface of the above mentioned items shall not contain above 0.25% lead content by weighted average. All piping, fittings, valve and equipment containing or conveying potable water shall comply with NSF 61 G and NSF 372 or shall be provided with indication on submittals the manufacturer’s declaration of self-certification.

1.7 DELIVERY, STORAGE, AND HANDLING (REFER TO SECTION 22 05 00)

A. Accept fixtures on site in factory packaging. Inspect for damage.

B. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.8 EXTRA MATERIALS (REFER TO SECTION 22 05 00)

A. General
1. Supply two sets of each different type of faucet washer, two flush valve service kits, two of each type of flush valve diaphragms, and two of each type of faucet cartridge.

PART 2 - PRODUCTS

2.1 LAVATORIES

A. Lavatory
1. Manufacturers (Refer to Section 22 05 00):
a. American Standard
b. Kohler
c. Toto
d. Karran
2. See schedule on drawings and provide products with same features as scheduled product.
a. Vitreous china ANSI A112.6.1 or acrylic as scheduled
b. Flow rates: as scheduled.
c. Self rimming counter top, wall mount or undermount as scheduled.
d. Provide with seal of putting, caulking or concealed vinyl gasket.

B. Manual Faucet
1. Manufacturers (Refer to Section 22 05 00):
a. Chicago
b. Symmons
c. T & S
d. Moen
e. Chrome plated brass body with manually adjustable hot/cold single or dual lever actuation as scheduled; adjustable limit stop; replaceable ceramic disc cartridge type; flow restriction for flow rate scheduled on drawings with aerator; vandal resistant.

2.2 WATER CLOSETS

A. Water Closet
1. Manufacturers (Refer to Section 22 05 00):
a. American Standard
b. Kohler
c. Toto

B. See schedule on drawings and provide products with same features as scheduled product.
1. Floor mounted
2. Flush valve water closets: Siphon jet; ANSI A112.6.1 vitreous china closet bowl; elongated rim; 1½ inch top spud; china bolt caps
3. Flow rates as scheduled on drawings

C. Flush Valve Automatic (see schedule for style)
   1. Manufacturers (Refer to Section 22 05 00):
      a. Sloan
      b. Zurn
   2. ANSI A112.18.1; concealed rough brass or exposed chrome plated as indicated on the drawings in the schedules; diaphragm type with battery operated solenoid operator as indicated on the drawings in the schedules; infrared sensor and over-ride button in chrome plated plate; wheel handle stop and vacuum breaker.

D. Seat
   1. Manufacturers (Refer to Section 22 05 00):
      a. Bemis
      b. Church
      c. Beneke
      d. Olsonite
   2. Solid white plastic; open front; extended back; brass bolts; without cover, check hinge.

2.3 URINALS

A. Urinal
   1. Manufacturers (Refer to Section 22 05 00):
      a. American Standard
      b. Kohler
      c. Toto
   2. ANSI A112.6.1 Vitreous china; wall hung; wash-out; shields; integral trap; removable stainless steel strainer; ¾ inch top spud

B. Flush Valve Automatic (see schedule for style)
   1. Manufacturers (Refer to Section 22 05 00):
      a. Sloan
      b. Zurn
   2. ANSI A112.18.1; concealed rough brass or exposed chrome plated as indicated on the drawings in the schedules; diaphragm type with battery operated solenoid operator as indicated on the drawings in the schedules; infrared sensor and over-ride button in chrome plated plate; wheel handle stop and vacuum breaker.

2.4 FLOOR-MOUNTED SERVICE SINKS (MOP SERVICE BASIN)

A. Sink
   1. Manufacturers (Refer to Section 22 05 00):
      a. Stern Williams
      b. Fiat
      c. Florestone

B. See schedule on drawings and provide products with same features as scheduled product.

C. Trim; Same manufacturer as fixture.

1. 5 feet of ½ inch diameter plain end reinforced rubber hose, hose clamp, mop hanger, and wall splash panels

D. Faucet
   1. Manufacturers (Refer to Section 22 05 00):
      a. Speakman
      b. Chicago
      c. T & S
      d. Zurn
   2. Exposed wall type supply; spout wall brace; vacuum breaker; hose end spout; strainer' eccentric adjustable inlets; integral screwdriver check stops with covering caps and adjustable threaded wall flanges

2.5 STAINLESS STEEL SINKS

A. Sink
   1. Manufacturers (Refer to Section 22 05 00):
      a. Elkay
      b. Just
   2. ANSI A112.19.3; 18 gauge Type 302 stainless steel; self-rimming or undermount as scheduled and undercoated; ledge back drilled for trim

B. Faucet
   1. Manufacturers (Refer to Section 22 05 00):
      a. Chicago
      b. Symmons
      c. T & S
   2. Chrome plated cast brass body and tubular brass swing spout with manually adjustable hot/cold lever(s); replaceable ceramic disc type flow restriction with swivel aerator. Single or dual lever handle as scheduled, with or without retractable sprayer/hose assembly as scheduled on drawings.

C. See schedule on drawings and provide products with same features as scheduled product.
   1. Flow rate as scheduled on drawings.

2.6 ELECTRIC WATER COOLERS/BOTTLE FILLING STATIONS

A. Manufacturers (Refer to Section 22 05 00):
   1. Elkay
   2. Haws
   3. Oasis

B. ARI 1010; electric water cooler with stainless steel top; surface, semi-recessed, recessed, or handicapped mounted as indicated in the drawings on the schedules; stainless steel body as indicated in the drawings on the schedules; elevated anti-squirt bubbler with stream guard; automatic stream regulator; push button; mounting bracket; refrigerated with integral air cooled condenser and stainless steel grille. Refrigerated with integral air cooled condenser and stainless steel grille. Mounting bracket.
   1. Provide with water filter certified to NSF/ANSI 42 and 53.

2. Unit certified to NSF/ASSI 61.
3. ADA, dual height.
4. Bottle fillers- integral with drinking fountain as scheduled.

2.7 EMERGENCY EYE WASH AND DRENCH HOSE

A. Manufacturers (Refer to Section 22 05 00):
   1. Guardian
   2. Haws
   3. Speakman

B. ANSI Z358.1; wall-mounted as scheduled on the drawings; self-cleaning; non-clogging eye and face wash with quick opening, stay-open full-flow valves; stainless steel eye and face wash receptor; twin eye wash heads and face spray ring; stainless steel dust cover; copper alloy control valve and fittings. Flow: as scheduled on drawings.

2.8 EMERGENCY SHOWERS AND EYEWASH COMBINATION UNIT

A. Manufacturers (Refer to Section 22 05 00):
   1. Guardian
   2. Haws
   3. Speakman
   4. Acorn Safety

B. ANSI Z358.1; wall-mounted as scheduled on the drawings; self-cleaning; non-clogging 8-1/8 inch diameter stainless steel deluge shower head with elbow; 1 inch full flow, stay-open valve ;8 inch diameter ring; 1 inch interconnecting fittings. 20 gpm minimum flow

2.9 WASH FOUNTAINS

A. Manufacturers (Refer to Section 22 05 00):
   1. Bradley
   2. Acorn
   3. Willoughby

B. Semi-circular models accommodate up to 4 users (54" models) at a time. The operating range is 20-80 PSI.

C. Bowl: One-piece pressing of 14 GA stainless steel with a #4 polished finish.

D. Pedestal: Constructed of die-formed legs, upper braces, scuff bases and panels: legs are zinc chromate plated 14 gauge steel; upper braces are 16 gauge galvanized steel; and scuff bases and pedestal panels are 300 series stainless steel with a #4 finish.

E. Valves and Fittings: In addition to the bowl and pedestal, the following valves and fittings are standard: sprayhead with stainless steel support tube and bowl gasket; spud with domed strainer; sprayhead supply line; manual mixing valve; volume control valve; and (2) stop, strainer and check valves.

F. Activation Controls: See schedule on drawings for type:
1. Infrared: Hands placed within the bowl are detected by an infrared sensor module which activates a flow of tempered water from the classic non-sectional sprayhead. Shut-off is automatic seven seconds after hands are removed from detection area. The infrared sensor uses a conical- shaped transmitting beam, having a detection area adapted to, but not exceeding, the bowl perimeter. The detection area projects forward 15° to each side and 15° below and extends 6 to 9 inches from the sensor module. The infrared sensor is not affected by varying color tones or darkness. Direct sunlight or bright washroom lights will not activate the system. Infrared models also include solenoid valves and a 12V plug-in adapter as standard equipment:
   a. Solenoid – 12VDC, 3/4" NPT. Few moving parts, and resistant to most chemicals, minerals, and impurities often present in municipal water supplies.
   b. Low-Voltage UL/CSA listed 120VAC/12VDC plug-in adapter. Plugs into a standard GFCI protected electrical outlet. Location of plug-in adapter per local electrical code.
   c. Each low-voltage mechanical pushbutton or piezo switch actuates a non-hold-open, slow- closing anti-hammer solenoid valve that is timed from an electronic potted assembly. Each push button activates a flow of tempered water from the classic non-sectional sprayhead. TouchTime controls water flow at all stations through the use of solid state, digital circuitry. Timing is factory set at 12 second run time but is field adjustable to pre-set timeout periods and optional auto-flush function. The 24 hour flush function will activate water flow for a period of 60 seconds any time there has been no activation within the past 24 hours. Push button and piezo switch requires less than five pounds of pressure.

2.10 WALL CARRIERS

A. Manufacturers (Refer to Section 22 05 00):
1. J.R. Smith (Basis of Design)
2. Zurn

B. Urinals
1. J.R. Smith Fig. 637

C. Lavatories
1. ANSI A112.6.1; cast iron and steel frame with tubular legs; lugs for floor and wall attachment; threaded studs for fixture hanger; concealed arm supports; bearing plate and studs
2. J.R. Smith Fig 700 frame wall application
3. J.R. Smith Fig 720, 722, or 727 for masonry wall application

2.11 STOPS/SUPPLIES & WASTE FITTINGS

A. Stop
1. Manufacturers (Refer to Section 22 05 00):
   a. Brass Craft
   b. Dearborn Brass
   c. Chicago
2. Comply with NSF/ANSI 61. Chrome plated brass 1/4 turn ball type stop with inlet connection matching water supply piping type and size. Outlet matching fixture inlet

type and size. Loose key operation. Include chrome plated wall flange. Inlets to be IPS x compression outlet. Compression inlet x compression outlet

B. Supplies
1. Chrome-plated-brass pipe or chrome-plated-copper tube matching faucet inlet piping size.
2. Braided or corrugated-stainless-steel flexible hose riser matching faucet inlet piping size

C. Waste Fitting
1. Chrome plated 17 ga. Tailpiece and chrome plated wall flange
2. Grid type or pop-up type drain with 1-1/4 inch tailpiece, at accessible lavatory locations. Chrome plated piping with chrome plated wall flange
3. Grid type or pop-up type drain with 1-1/4 inch tailpiece, at lavatory locations. 1-1/4 inch x 17 ga. P-trap
4. Grid type or pop-up type drain with 1-1/4 inch offset tailpiece, at accessible lavatory locations. 1-1/4 inch x 17 ga. P-trap
5. Basket type strainer with 1-1/2” tailpiece at sink locations. Provide continuous waste fitting for sinks with double bowls
6. Chrome plated brass with wall flange.

2.12 PROTECTIVE SHIELDING GUARDS

A. Protective shielding Pipe Covers:
1. Manufacturers (Refer to Section 22 05 00):
a. TRUBRO INC.
b. Plumberex Specialty Products Inc.
2. Manufactured plastic wraps for covering hot and cold water supplies, trap and drain piping at fixtures. Comply with Americans with Disabilities Act (ADA) requirements

2.13 DISPOSERS

A. Manufacturers (Refer to Section 22 05 00):
1. In-Sink-Erator
2. Or approved equal.

B. Batch-feed household, food-waste disposer. Include reset button, wall switch; corrosion resistant chamber with jam-resistant, cutlery- or stainless-steel grinder or shredder; NPS 1-1/2 outlet; quick mounting, stainless-steel sink flange; anti-splash guard; and combination cover/stopper.

C. Motor: 115-V AC. 1725 rpm, ½ hp with overload protection. Disposal shall include minimum 3’ power cord for power by receptacle.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that walls and floor finishes are prepared and ready for installation of fixtures.

B. Verify that electric power is available and of the correct characteristics.

C. Confirm that millwork is constructed with adequate provision for the installation of counter top lavatories and sinks.

3.2 PREPARATION

A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture schedule for particular fixtures.

3.3 INSTALLATION

A. Provide as detailed and in accordance with manufacturer's instructions.

B. Provide concealed wall carriers for wall mounted fixtures as specified and as required for fixture installation.

C. Install each fixture with trap, easily removable for servicing and cleaning.

D. Provide chrome plated rigid or flexible supplies to fixtures with loose key stops, reducers, and escutcheons.

E. Attach water supplies to supports or substrate within the pipe spaces behind fixtures

F. Install stops where they can be easily accessible for operation

G. No slip joints will be allowed on supplies

H. Install components level and plumb.

I. Install and secure fixtures in place with wall carriers and bolts. All wall hung lavatories shall have concealed arm carriers.

J. Seal fixtures to wall and floor surfaces with sealant as specified in Division 7, color to match fixture.

K. Solidly attach water closets to floor with lag screws. Lead flashing is not intended hold fixture in place.

L. Provide flush valve down tube offset as required to avoid handicapped grab bar at accessible water closet locations

M. Install molded-type protective shielding pipe covers or enclosures on exposed supplies and waste piping at accessible lavatories and sinks. Protective shielding shall be included for hot water, cold water and p-trap, tailpieces and offsets.

N. Install toilet seats on water closets

O. Install disposer in sink in all break rooms, two total. Refer to the electrical drawings for location of wall switch adjacent to sink for activation of disposal.

P. Refer to Architectural drawings for exact locations and mounting heights.

3.4 INTERFACE WITH OTHER PRODUCTS

A. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation

3.5 ADJUSTING

A. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

B. Adjust time-out settings for sensor operated faucets

3.6 CLEANING (REFER TO SECTION 22 05 00)

A. Clean plumbing fixtures and equipment.

3.7 PROTECTION OF FINISHED WORK

A. Section 22 05 00 – Common Work Results for Plumbing - Protecting installed work

B. Do not permit use of fixtures.

END OF SECTION

SECTION 23 05 00

COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 CONDITIONS AND REQUIREMENTS

A. Refer to Divisions 00 & 01 of these specifications, which govern work under Division 23. Refer to other sections of these specifications for additional related requirements.

1.2 SCOPE OF REQUIREMENTS

A. The work covered by Division 23 of the specifications (HVAC/Mechanical) shall include but not limited to furnishing all materials and supplying all labor, equipment, and services to install the complete mechanical systems as shown on the accompanying drawings and specified herein.

B. Work done under Division 23 of the specifications shall comply with the requirements specified herein.

1.3 ALTERNATES (REFER TO DIVISION 00)

A. The bid price for each alternate shall include a complete working Division 23 system as described in the alternates, shown on the drawings, and indicated in these specifications.

1.4 CODES, PERMITS AND FEES

A. Division 23 work shall be in accordance with the following as adopted by the governing agencies, including amendments:
   1. Americans with Disabilities Act (ADA)
   2. Applicable State and Local Codes and Ordinances
   3. National Electrical Code
   4. International Building Code
   5. International Fire Code
   6. International Mechanical Code
   7. Idaho State Plumbing Code
   8. International Fuel Gas Code
   9. International Energy Conservation Code (with Idaho State Amendments)

B. Permits and inspections required for the Division 23 work on this project shall be obtained as part of the Division 23 scope of work, and the cost for these permits

and inspections shall be included in the Division 23 bid. All inspection certificates shall be delivered to the Owner's Representative prior to final acceptance of the work in accordance with the requirements of these specifications.

C. All costs levied by utility companies and/or governing agencies shall be included in the Division 23 scope of work and shall be included in the Division 23 bid.

D. Work shall comply with all regulations associated with all applicable utilities.

1.5 INTENT AND INTERPRETATIONS

A. It is the intent of these plans and specifications to result in a complete and working Division 23 installation in complete accordance with all applicable codes and ordinances.

B. The drawings and these specifications are intended to supplement each other. Any details contained in either the drawings or these specifications shall be included as if contained in both.

C. Items not specifically mentioned in the specifications or noted on the drawings, but which are necessary to make a complete working installation shall be included.

1.6 DEFINITIONS

A. The term "Acceptance", when used in Division 23, shall be defined as the Owner's assumption of ownership for part or all of the Division 23 system. Acceptance of part or all of the Division 23 system, when granted prior to completion of Division 23 work and/or correction of deficiencies, shall not relieve Division 23 of any responsibility for completion of this work and/or correction of these deficiencies.

B. The term "Date of Acceptance", when used in Division 23, shall be the official date when Acceptance, as defined in these specifications, occurs. The Date of Acceptance shall be assumed to coincide with granting of Substantial Completion unless noted otherwise by the Owner's Representative. Deviation of the Date of Acceptance from Substantial Completion can assume to have occurred only when written documentation is provided by the Owner's Representative specifically indicating this separation and identifying an alternative designation for the Date of Acceptance.

C. The terms "The Contractor" or "This Contractor", when used, shall be defined as the Contractor responsible for Division 23 work.

D. The term "Owner's Representative", when used, shall refer to the Architect or their designated representative in accordance with Division 00 and 01.

E. The term "Provide" shall mean furnish and install.

F. The term " HVAC" or "Mechanical", when used, to distinguish a particular scope of work or portion of the documents, shall mean the Division 23 scope of work and Division 23 documents (drawings and specifications) respectively.

1.7 DRAWINGS

A. HVAC and Mechanical drawings show general arrangement of piping, ductwork, equipment, etc. Drawings shall be followed as closely as actual building construction and work of other trades will permit.

B. Architectural and Structural drawings and specifications shall be considered part of this work insofar as they furnish information relating to design and construction of the building. These documents take precedence over Division 23 drawings and specifications if any dimensional discrepancies exist.

C. Drawings are diagrammatic only. Consequently, all required duct and pipe offsets are not indicated on the drawings. Offsets as required to meet the design intent of the drawings shall be provided.

1.8 GUARANTEE (REFER TO DIVISIONS 00 AND 01)

A. The Division 23 equipment, materials, and installation shall be guaranteed for a period of one (1) year unless an individual item or specification is otherwise noted as longer. All defects in Division 23 work and/or equipment furnished that develop at any time during the one year guarantee period shall be corrected at no cost to the owner, including any expenses for cutting, patching, and repairing made necessary by corrections of unsatisfactory work and/or damage resulting from incorrect equipment operation.

B. The guarantee period shall begin upon the Date of Acceptance. When Acceptance is granted for portions of the Division 23 system at different times, the guarantee for each portion of the Division 23 system shall begin upon Acceptance of that portion of the Division 23 system.

C. Permission to use the permanent Mechanical system for temporary heating during construction does not constitute acceptance. All product and system warranties shall be extended at no cost to the Owner as required to maintain this one (1) year requirement from the Date of Acceptance if such permission is given.
   1. Exception: Use of part or all of the Division 23 system prior to the Date of Acceptance, when initiated by the Owner, shall constitute Acceptance of the specific piece of equipment and/or portion of the system only when acknowledgement of Acceptance is noted in written authorization from the Owner as required in these specifications.

D. Equipment warranties in addition to this guarantee shall be provided in accordance with the table at the end of this section.

1.9 FILTERS

A. Refer to paragraph “Use of Equipment During Construction” Section 23 05 00.

B. New filters shall be installed prior to system startup.

C. If systems are operated prior to testing, adjusting, and balancing (TAB), new filters shall be installed prior to starting (TAB) work.

D. Filters in portions of Division 23 systems that are completed and used prior to overall project substantial completion shall be changed as required to protect the Division 23 systems.

E. New filters shall be provided at time of overall project substantial completion. In addition, an extra set shall be furnished as additional stock.

1.10 COST BREAKDOWN

A. Refer to Divisions 00 and 01 for supplemental requirements.

B. A breakdown of the HVAC construction cost shall be furnished to the Owner’s Representative within 30 days of Notice to Proceed, with separate costs for each of the items listed in the cost breakdown in Part 4 of this section.

1.11 PAYMENT REQUESTS

A. Refer to Divisions 00 and 01 for supplemental requirements.

B. Payment requests for materials and equipment will not be reviewed or approved until submittals and operation and maintenance data have been received and approved.

C. Payment requests for the Energy Management and Control System (EMCS) will not be reviewed or approved until submittals required under Section 23 09 23 have been received. Once these submittals have been received, only payment requests for programming and submittals will be reviewed until all submittals required under Section 23 09 23 have been reviewed and approved. Payment requests for materials and/or installation will not be reviewed prior to approval of all submittals required under Section 23 09 23.

D. Payment requests for materials will only be available if the materials are stored in alignment with DPW’s requirements. Approval of submittals does not allow the Contractor the right to initiate a payment request.

1.12 USE OF EQUIPMENT DURING CONSTRUCTION

A. Use of the building permanent systems is not allowed during construction with the exception of renovations in partially occupied facilities. When existing systems must remain operational, the heaviest work areas should be dampered and sealed off or otherwise blocked if temporary imbalance of the return air system does not create a greater problem.

B. The mechanical room and air handling unit equipment shall not be used to store construction or waste materials.

C. Temporary heating for the facility during the construction phase shall not be supplied by the permanent system installed under Division 23 unless Contractor shall obtain a letter of approval from the Owner stating that they understand equipment expected life may be shortened due to severe usage.

D. If the Contractor is given permission to use permanent systems for space heating during construction:
   1. The Contractor shall be responsible for pressure cleaning all coils and vacuum cleaning all ductwork prior to occupancy if deemed necessary by the Owner's Representative.
   2. Product warranties shall be extended as required to account for construction use. Warranty periods offered by equipment manufacturers and/or required by these specifications shall begin at the Date of Acceptance. If equipment manufacturers require that the warranty period begin with use of equipment during construction, the Contractor shall bear the expense of extending all such warranties to maintain the required warranty period beyond the Date of Acceptance.
   3. Filters shall be installed meeting the requirements of the drawings and these specifications for the permanent system. Systems which have multiple stages of filtration shall have filters installed meeting the requirements of the drawings and these specifications for the first level of filtration. In addition to the requirements for the permanent system, filters provided during construction shall have a Minimum Efficiency Reporting Value (MERV) rating of 13 whether such a rating is required for the permanent system or not. New filters shall be installed prior to system balancing. Units shall not be operated without filters in place. Check and change filters at intervals sufficient to protect the Division 23 system.
   4. Filter fabric shall be provided at all return grilles subject to airborne construction debris. Filter fabric shall be replaced at intervals sufficient to protect the Division 23 system. Filter fabric shall be removed prior to system balancing.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS – STANDARDS AND CODES

A. Materials used under this Contract, unless specifically noted otherwise, shall be new and of the latest and most current model line produced by the manufacturer. Outdated “new” equipment is not acceptable. Each item of equipment and material shall conform to the latest Standard Specifications of the American Society for Testing Materials and shall conform to any applicable standards of the United States Department of Commerce.

B. Motor and equipment name plates as well as applicable UL and AGA labels shall be in place when the project is turned over to the Owner.

C. Motor efficiencies shall meet or exceed the requirements of the applicable energy code.

D. All electrically driven or connected equipment shall be provided with UL or equivalent label and/or listing in accordance with the requirements of the NEC.

E. Equipment shall be UL listed as an assembly where listing/labeling program is available for that type of equipment.

F. All control panels shall be provided with UL or equivalent label and/or listing in accordance with the requirements of the NEC and applicable local electrical codes.

G. Fuel fired equipment shall be listed by a nationally recognized testing laboratory for use with the particular fuel type.

H. All pressure vessels and relief valves shall be furnished in accordance with applicable State Boiler and Unfired Pressure Vessel Laws. This shall include rating and stamped in accordance with the ASME Boiler and Pressure Vessel Code where required by Code authorities or State Law.

2.2 EQUIPMENT/MATERIAL SUBSTITUTIONS

A. Throughout these specifications and drawings, various materials, equipment, apparatus, etc., are specified or scheduled by manufacturer, brand name, type or catalog number. Such designation is to establish standards of desired quality and construction and shall be the basis of design and the bid.

B. Substitutions will not be permitted without written approval. (Refer to Divisions 00 and 01.)

C. Where two or more manufacturer designations are listed in these specifications, choice will be optional with the Contractor except that where more than one manufacturer is listed and only one manufacturer’s catalog number is specified or

only one manufacturer scheduled on the drawings (basis of design), that standard of quality, dimensional characteristics, capacities, and construction shall be maintained by materials or equipment supplied by the other manufacturer(s).

D. Substituted equipment with efficiencies less than 99% of the basis of design efficiency shall not be considered equal to the basis of design.

E. If the Division 23 Contractor uses manufacturers other than the basis of design, the Contractor shall be responsible for:
   1. Insuring the substituted item will fit the available space while allowing proper maintenance access
   2. Any changes required by other Contractors caused by the substituted equipment
   3. Changes in electrical requirements: See “Equipment Substitutions – Electrical Characteristics” below
   4. Changes in structural design due to weight differences

F. In the event other than specified equipment is used and will not fit job site conditions, this Contractor shall assume responsibility for replacement with items indicated as the basis of design.

G. Substitutions not approved during bid will not be accepted.

2.3 EQUIPMENT SUBSTITUTIONS – ELECTRICAL CHARACTERISTICS

A. Products furnished other than the basis of design shall have similar electrical characteristics as the scheduled or specified equipment. The Contractor shall be responsible for any electrical changes caused by products not in accordance with this requirement.

2.4 SUBMITTALS FOR REVIEW

A. Refer to Divisions 00 and 01 for supplemental requirements.

B. Shop drawings, catalog information and material schedules shall be submitted for approval on all specified materials and equipment in Division 23 prior to ordering.

C. The Contractor shall create a comprehensive submittal list of all Division 23 equipment, piping, accessories, and more that shall be submitted on. The comprehensive list shall be sent to the Engineer prior to starting the submittal process for approval.

D. Provide specific wiring diagrams for all equipment requiring electrical or control wiring. Upon approval, copies of these diagrams shall be forwarded to pertinent contractors.

E. Furnish complete shop drawing/catalog data for equipment and materials to be used in the work for review. Allow sufficient time for developing shop drawings, processing and review time so that the installation will not be delayed.

F. Shop drawings shall be reviewed, approved and stamped by the Contractor prior to submitting to Owner's Representative for approval. Submittals without such approval will be returned without review.

G. Where choices of options and accessories are available or specified, provide written description of what is to be furnished. If necessary, list page numbers where submitted items are described.

H. State sizes, capacities, brand names, motor horsepower, electrical characteristics, accessories, materials, gauges, dimensions, and other pertinent information.

I. Underline applicable data.

J. If material or equipment is not as specified or submittal is not complete, it will be rejected. Only complete submittal including all applicable specification sections will be reviewed.

K. Field applied adhesives, sealants, fillers, primers, glues, and paint shall have VOC's that are equal to or lower than the requirements as identified in part 3 of this section.

L. Provide cut sheets and a Material Safety Data Sheet (MSDS) for each field applied sealant, adhesive, coating, paint etc used in the building, highlighting VOC limits and chemical component limits. Also indicated in additional to actual VOC emissions identify allowed limits of each product to demonstrate compliance. Submit all proposed field applied products as a single submittal for review with their MSDS data.

M. Catalog data or shop drawings for equipment which are noted as being reviewed shall not supersede Contract Documents.

N. Review comments shall not relieve the Contractor from responsibility for deviations from Contract Documents unless attention has been called to such deviations in writing at time of submission, nor shall they relieve this Contractor from responsibility for errors in items submitted.

O. Check work described by catalog data with Contract Documents for deviations and errors.

P. Shop drawings and submittal information shall be provided for all required Division 23 equipment.All Division 23 sections shall have a dedicated submittal and shall include all products with the section. Incomplete submittals will be rejected without review.

Q. Submittal Format:

1. Electronic submittals shall be provided with accordance with all of the following conditions. Electronic submittals which do not comply with all of these conditions will be rejected without review.
   a. Electronic submittals shall be submitted in the current version of Adobe Portable Document Format (PDF)
   b. Submittals shall be original PDF's of the document and shall not be created using scanned copies of paper documents.
   c. PDF documents shall be searchable.
   d. PDF documents shall be unlocked
   e. Electronic submittals shall be separated by specification section and identified as such. Submittals which combine multiple sections into a single document will be rejected.
   f. Electronic submittals shall include a table of contents and each applicable section shall be bookmarked for easy access.
   g. Electronic submittals shall be clearly marked in RED using boxes and arrows and other appropriate markings to indicate specific product information, option selections, accessories, etc.

R. Each product shall be keyed to the paragraph number in the specifications.

S. Operation and maintenance data for individual equipment shall also be provided subsequent to approval of equipment submittals in a separate binder meeting the same requirements as the submittal binder. Refer to Part 3 of this specification for supplemental requirements.

T. All submittals and re-submittals as required shall be provided with a cover page incorporating a table similar to that provided at the end of this section. The appropriate box(es) shall be checked on each line item for all submittals.

PART 3 - EXECUTION

3.1 LOCATIONS

A. Coordination of Division 23 equipment and systems to the available space, with other trades and to the access routes through the construction shall be the Contractor's responsibility.

B. Drawings are diagrammatic. Make offsets, transitions, and changes in direction of pipes and ducts as required to maintain proper head room and pitch of sloping lines and avoid structural, electrical, pipe and duct interferences whether or not indicated on Drawings. Furnish fittings, etc., as required to make these offsets, transitions and changes in direction at no additional cost to the Owner.

C. Pipe and duct routing shall be coordinated and verified with all trades prior to fabrication and installation. Additional project costs resulting from failure to do so shall be the Contractor's responsibility.

D. Determine exact route and location of each pipe and duct and coordinate and obtain approval for changes from the layout indicated on the drawings with the Owner's Representative prior to fabrication.

E. Locations of equipment and devices, as shown on the drawings, are approximate unless dimensioned. Verify the physical dimensions of each item of Division 23 equipment to fit the available space and promptly notify the Owner's Representative prior to roughing-in if conflicts appear.

F. All piping, wiring, equipment, ductwork, tubing, etc., shall be concealed within building construction unless otherwise noted, or in Division 23 rooms.

G. Arrange pipes, ducts, and equipment to permit ready access to valves, unions, traps, trap primers, starters, motors, control components, and to clear openings of doors and access panels.

3.2 SCHEDULING

A. It is understood that while drawings are to be followed as closely as circumstances permit, the Contractor shall be responsible for installation of systems according to the true intent and meaning of Contract Documents. Anything not clear or in conflict will be explained by making application to Owner's Representative. Should conditions arise where certain changes would be advisable, secure approval from Owner's Representative for those changes before proceeding with work.

B. The contractor shall coordinate with the work of various trades when installing interrelated work. Before installation of Division 23 items, proper provisions shall be made to avoid interferences. Changes required in work specified in Division 23 caused by neglect to do so shall be made at no cost to Owner.

C. Supports and inserts in concrete required for Division 23 supports shall be furnished and installed unless otherwise noted. Furnish sleeves, inserts, supports, and equipment that are an integral part of other Divisions of the Work to those involved in sufficient time to be built into construction as the Work proceeds. Locate these items and see that they are properly installed. Expense resulting from improper location or installation of items above shall be borne under Division 23.

3.3 CUTTING AND PATCHING

A. All cutting and patching of new and existing construction required for the installation of systems and equipment specified in Division 23, including patching of existing walls, floors, and roofs upon removal of existing Division 23 systems and equipment, shall be the responsibility of the Division 23 Contractor. All cutting shall be accomplished with masonry saws, drills or similar equipment to provide neat uniform openings.

B. Walls, floors, ceilings and roof shall be patched and repaired with materials of same quality and appearance as adjacent surfaces unless otherwise shown. Surface finishes shall exactly match existing finishes of same materials. All patching shall meet the approval of the Owner's Representative.

C. All cutting and patching made necessary to repair defective equipment, defective workmanship or by neglect of this Contractor to properly anticipate their requirements shall be included in Division 23.

D. Cut carefully to minimize necessity for repairs to existing work. Do not cut beams, columns, or trusses or other structural members without the Owner Representative's written approval.

E. Cutting, patching, repairing, and replacing pavement, sidewalks, roads, and curbs to permit installation of work specified or indicated under Division 23 is responsibility of Division 23.

3.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Refer to Divisions 00 and 01 for supplemental requirements.

B. Follow manufacturer's directions in delivery, storage, protection, and installation of equipment and materials.

C. Promptly notify Owner's Representative in writing of conflicts between requirements of Contract Documents and Manufacturer's directions and obtain written instructions from Owner's Representative before proceeding with work. The Contractor shall bear expenses arising from correcting deficiencies of work that do not comply with manufacturer's directions or such written instructions from Owner's Representative.

D. Deliver equipment and material to site and tightly cover and protect against dirt, water, and chemical or mechanical injury but have readily accessible for inspection. Store items subject to moisture damage (such as controls) in a dry, heated space.

E. Notify Owner of equipment delivery dates twenty-four (24) hours in advance of delivery.

F. The Contractor shall be responsible for protection of equipment furnished in Division 23 from vandalism and weather during all phases of construction. Damaged equipment shall be restored to like new condition or replaced at the Contractor's expense.

G. Ductwork shall be protected and handled in accordance with SMACNA Intermediate Level of duct cleanliness for new construction. Ductwork shall be stored on pallets off of grade in an area that is clean, dry and exposure to dust is minimized. Internally lined ductwork and air handling equipment shall be kept dry.

Internal insulation that has been allowed to become wet will be rejected. Air handling equipment that has been allowed to become wet may be rejected.

H. Any factory painted equipment scratched or marred during shipment or construction shall be restored to original “new” condition. This includes complete repainting if necessary to provide exact paint match.

3.5 VISITING THE PROJECT SITE

A. The premises shall be examined and conditions shall be understood which may affect performance of work of Division 23 before submitting proposals for this work.

B. No subsequent allowance for time or money will be considered for any consequence related to failure to examine site conditions.

3.6 TESTS

A. See individual specification sections for Testing Requirements.

3.7 COMMISSIONING SUPPORT

A. The equipment and systems referenced in the Related Work section are to be commissioned per Division 1 and Division 23 commissioning specifications. The contractor has specific responsibilities for scheduling, coordination, startup, testing and documentation. Coordinate all commissioning activities with the Commissioning Authority.

B. Include allowance in the bid to support commissioning. Allowance shall be a separate line item on the schedule of values.

C. Include time for commissioning activities on the construction schedule to complete commissioning prior to substantial completion with the exception of seasonal testing which the commissioning agent determines should coincide with peak heating and cooling weather conditions.

D. Related Work: All Sections in Division 23.

3.8 LOW EMITTING MATERIALS

A. All field applied wet coatings, paints, adhesive and sealants that are installed within the water proofing membrane with Volatile Organic Compounds shall not exceed the limits below.

B. Allowed limits for architectural coatings per South Coast AQMD Rule 1113 effective February 5, 2016 (g/l):

1.	Mastic Coatings	100
2.	Metallic Pigmented Coatings	150
3.	Multi Color Coatings	250
4.	Non Flat coatings	50
5.	Pre-Treatment Wash Primers	420
6.	Primers/Sealants/Undercoats	100
7.	Reactive Penetrating Sealers	350
8.	Clear Shellac	750
9.	Pigmented Shellac	550
10.	Specialty Primers	100
11.	Water Proofing Sealers	100
12.	Other:	Consult Rule 1113.

C. Allowed Limits for sealants per South Coast AQMD Rule 1168 effective October 2017 (g/l):

1.	Contact adhesive	350
2.	Edge Glue Adhesive	250
3.	Plastic ABS Welding Cement	325
4.	ABS to PVC transition cement	510
5.	CPVC Welding Cement	490
6.	PVC Welding Cement	510
7.	Other plastic welding cements	250
8.	Foam Insulation	250
9.	Foam Sealant	250
10.	Grout	65
11.	Non Staining plumbing putty	150
12.	Butyl Tapes	250
13.	Fiberglass Duct Liner adhesives	80
14.	Other-Duct Sealants	420
15.	Other sealants:	Consult Rule 1168.

3.9 CONSTRUCTION IAQ MANAGEMENT DURING CONSTRUCTION

A. All work shall conform with Division 1. Coordinate closely with the general contractor.

B. During Construction meet or exceed the minimum requirements of the SMACNA IAQ Guideline for Occupied Buildings. For new buildings, best management practices shall meet or exceed the requirements of this section.

C. Prepare and submit a written IAQ Management Plan that identifies construction activities that conforms with IAQ Best Management Practices. Submit to the general contractor for review.

D. Acceptable IAQ Management Best Management Practices
1. Summary: Many Best Management Practices are available to maintain IAQ during construction or demolition. The pros, cons, and limitations of each available option should be considered to identify the most effective and most efficient approaches for a particular job. When designing the Plan, the

Contractor may use more than one of these practices (simultaneously or phased in) as work progresses. In general, the choices involve:
a. Containing the work area.
b. Modifying operation.
c. Reducing emissions.
d. Intensifying housekeeping.
e. Rescheduling work hours or moving occupants.

2. If air handlers are used during construction, filtration media with a Minimum Efficiency Reporting Value (MERV) of 8 must be used at each return air grille, as determined by ASHRAE 52.2-1999. Replace all filtration media immediately prior to test and balance and occupancy with filters specified in Section 23 73 00. Filtration media shall meet or exceed Minimum Efficiency Reporting Value (MERV) specified in Section 23 40 00 as determined by ASHRAE 52.2- 1999.
3. Hazardous wastes shall be separated, stored, and disposed of according to local regulations.
4. Storage and Protection: Designate receiving/storage areas for incoming material to be delivered according to installation schedule and to be placed convenient to work area in order to minimize waste due to excessive materials handling and misapplication. Protect stored on-site or installed absorptive materials from moisture damage.
5. HVAC/Mechanical Systems.
   a. Protection: All systems and equipment must be protected from collecting dust and odors that can “stick” to porous materials in the system and later be released. The each system must be evaluated in detail to determine how it may be affected by odor and dust from the project (including site egress, staging areas, etc.).
   b. Return Side: The return side of an HVAC system is, by definition, under negative pressure and thus capable of drawing in nearby construction dust and odor. Special attention must be paid to the location of any return vents, return ducts, ceiling plenums, return shafts, VAV plenum intakes, window units, and transfer vents as well as that portion of the air handler which is upstream of the central fan. When possible, the entire system should be shut down during heavy construction or demolition.
      1) All return, exhaust and supply system openings in (or immediately adjacent to) the construction area should be sealed with plastic.
      2) When the system must remain operational during construction, temporary filters should be added where necessary (e.g., on return grilles and return ducts) with a minimum MERV 8 rating and a minimum MERV 6 filter shall be utilized at the respective piece of air terminal or air distribution equipment. All filters must receive frequent periodic maintenance and be replaced at the end of the project.
   c. Supply Side.
      1) Diffusers, VAV boxes, and ducts may be adequately protected in most cases where the above measures are implemented. When the system is off for the duration of construction, diffusers and window units should also be sealed in plastic for further protection.
      2) Ducts, diffusers, and window units should be inspected upon completion of the work for the amount of deposited particulate present

and cleaned where needed. If significant dust deposits are observed in the system during construction, some particulate discharge can be expected during start-up. When such a discharge is only minor, delaying re-occupancy long enough to clean up the dust may be sufficient. In more severe cases, installing temporary coarse filters on diffusers or cleaning the ducts may be necessary. The condition of the main duct should be checked whenever visible particles are discharged from the system.

6. Duct Cleaning: The condition of the main duct should be checked whenever visible particles are discharged from the system. An HVAC system has excessive dust or debris when an accumulation of particles can be observed under (not on) diffusers, or ventilation is restricted. Cleaning of the air distribution system shall be required when a clean system becomes contaminated due to inadequate protection during the Construction process. A decision whether and how to clean the ducts should be based on a detailed visual inspection of the system. Both highly specialized equipment and professional expertise are required to ensure that dust is effectively removed and contained. The sequence in which duct cleaning occurs in the overall construction process needs to be carefully considered to avoid re-contamination.
7. Modifying Equipment Operation: Use of equipment may need to be restricted in order to meet IAQ objectives. This could involve substituting cleaner equipment or simply changing operating Procedures. Examples of such controls include:
    a. Restricting traffic volume or prohibiting idling of motor vehicles where emissions could be drawn into occupied areas.
    b. Switching from diesel to bottled gas for equipment such as generators or fork lifts (emissions are cleaner but still potentially harmful under some circumstances). Use of electric fork lifts and other equipment should be considered when feasible, since they do not burn fossil fuels, thus eliminating exposure to combustion gas emissions.
8. Changing Work Practices: For some demolition tasks (e.g., paint stripping) there may be techniques available that produce less airborne dust. Some painting techniques release fewer odors. Some cleaning practices raise less dust.
9. Local Exhaust: Pollution sources can be directly exhausted to the outside. This may be done through an exhaust system already available in the building or more often by a portable fan vented to the outside and attached to the work site by flex duct. Depending on the nature of the material and the location of the exhaust, special filtration of the exhaust may or may not be necessary. Any emissions to the outside must be in compliance with applicable regulations and should be directed well away from intakes.
10. Air Cleaning: Where exhaust is not feasible, local re-circulation of air through a portable air cleaner may be effective. The type of filter should be suitable for the material being controlled (e.g., charcoal or potassium permanganate for many odors, a moderate to high efficiency filter for dust).
11. Cover or Seal: VOC emissions are a result of evaporation from an exposed surface. Reducing the exposed surface reduces emissions. For example:
    a. An enclosed tanker is preferable to an open kettle for roofing.

b. Containers of wet products should be kept closed as much as possible.
c. Waste materials that can release odor or dust should be covered or sealed.
d. Applying a sealer may control a surface that is a persistent odor source.

3.10 CONSTRUCTION IAQ MANAGEMENT PLAN POST CONSTRUCTION

A. Building Flushout: Make provisions for building flushout and schedule building flushout with closeout activities. Flushout period for shop areas shall be maintained for one week with 100% outside air and office areas shall be maintained for a two week period with 100% outside air. See Section 23 09 23 for supplemental information and temperatures to be maintained during the building flushout.

B. Provide a minimum 13 MERV filter during the building and cleaning flush out phase and replace with new minimum 13 MERV filters immediately prior to occupancy in accordance with Section 23 40 00. Provide product data submittal for proposed filters during cleaning and flushing.

3.11 CONSTRUCTION WASTE MANAGEMENT

A. As part of the sustainable construction process, construction waste may be salvaged or re-used. This is a collaborative effort and should be coordinated with the General Contractor who is responsible for administration of the construction waste management plan.

3.12 CHEMICAL WATER TREATMENT SUPPORT

A. Prior to water treatment being performed for closed loop systems the Division 23 and Section 23 09 23 contractors shall provide documentation that all control valves are connected and in operation and verify that all valves are in the open position for complete circulation of cleaning chemical. Documentation shall be provided at the end of each phase of work prior to commencement of the water treatment work.

B. See 23 25 00 for additional water treatment requirements.

3.13 PROJECT CLOSEOUT/OPERATION AND MAINTENANCE MANUAL

A. Electronic submittals shall be provided with accordance with all of the following conditions. Electronic submittals which do not comply with all of these conditions will be rejected without review.
1. Electronic submittals shall be submitted in the current version of Adobe Portable Document Format (PDF)
2. Submittals shall be original PDF’s of the document and shall not be created using scanned copies of paper documents.

3. PDF documents shall be searchable.
4. PDF documents shall be unlocked
5. Electronic submittals shall be separated by specification section and identified as such. Submittals which combine multiple sections into a single document will be rejected.
6. Electronic submittals shall include a table of contents and each applicable section shall be bookmarked for easy access.
7. Electronic submittals shall be clearly marked in RED using boxes and arrows and other appropriate markings to indicate specific product information, option selections, accessories, etc.
8. Each product shall be keyed to the paragraph number in the specifications.

B. Cover page shall include:
1. Job title
2. Date
3. Engineer
4. Architect
5. Contractor
6. Construction Division

C. Work shall be done in a print shop or bindery.

D. Provide a master index at the beginning of the manual showing items included. Use plastic tab indexes for the sections and sub-sections of the manual.

E. Manual shall be organized into the following five sections:
1. Contacts: This shall consist of name, address, and phone number of the following parties: Architect, Mechanical Engineer, Electrical Engineer, General Contractor, HVAC Contractor, Piping Contractor, Sheet Metal Contractor, Temperature Controls Contractor, Sprinkler Contractor, Electrical Contractor and major equipment suppliers.
2. Equipment
   a. Begin the Equipment section with a separate sub-section containing a list of the Division 23 equipment indicating:
      1) Equipment name and designation as it appears on the equipment schedule
      2) Area served
      3) Manufacturer
      4) Model
      5) Serial number
      6) Name plate data
   b. The remaining sub-sections shall include, at a minimum, the following for each item of Division 23 equipment. This material shall be organized in a separate tabbed sub-section for each section of the specifications. Within each sub-section, provide separate tabs for each item of equipment, referencing the equipment schedule designation. Provide the following information as applicable:
      1) Performance curves or tables showing the specified operating points and the operating points after final testing and balancing

2) Manufacturer's maintenance instructions: Instructions shall include name of vendor, installation instructions, parts numbers and lists, operation instructions of equipment, maintenance and lubrication instructions, troubleshooting guides, and overhaul specifications for major equipment.
3) Step-by-step procedure to follow in putting each piece of Division 23 equipment into operation
4) Wiring diagram for particular equipment item
5) Refer to individual specification sections for additional information required to be incorporated into the Operation and Maintenance Manual.

3. Maintenance Schedule and Spare Parts
   a. This shall include two sub-sections:
      1) The first sub-section shall consist of a preventative maintenance schedule summary table (or list). The table shall be organized by specification section and include:
         a) Equipment name and designation as it appears on the equipment schedule
         b) Equipment location
         c) Type and frequency of preventative maintenance requirements (including lubrication)
      2) The second sub-section shall consist of a list of spare parts furnished under this contract. The list shall be organized by specification section and include (similar to that included at the end of this section):
         a) Equipment name and designation as it appears on the equipment schedule
         b) Spare part furnished
         c) Verification by an Owner's Representative that the part(s) have been provided
4. Energy Management and Controls System
   a. Content shall be as specified in Section 23 09 23.
5. Warranties and Certifications
   a. Shall include:
      1) Test and balance reports
      2) Test records of piping, ductwork, etc
      3) Signed checklist of instruction period
      4) Copies of specific product warranties
      5) Copies of certified factory start-up reports
      6) Valve tag identification schedules
      7) Copy of manual describing specific maintenance services that will be furnished under this contract
      8) Fire sprinkler certification

F. Prepare two (2) printed copies in three ring binders of approved manuals for use during the instruction period.

G. Following instruction period, turn over both printed copies and electronic files to the Owner's Representative and the Owner.

H. Manuals may be compiled in multiple volumes if necessary for ease of use.

3.14 PROJECT CLOSEOUT/CERTIFIED FACTORY START-UP

A. Refer to individual sections of these Specifications for specific requirements of certified factory start-up.

B. Start-up shall be performed by a certified factory representative. Prior to start-up, certification of factory representative shall be forwarded to the Engineer for review.

C. Start-up shall be scheduled with the owner to allow witnessing of start-up procedures by maintenance personnel. Operation and maintenance training for equipment requiring certified factory start-up shall be conducted at the time of start-up with the certified factory representative present.

D. Certified factory start-up is required for the following equipment:
1. Chemical Water Treatment
2. Boilers
3. Mini Split Systems
4. Air Handling Units
5. Make Up Air Units
6. Variable Frequency Drives
7. Airflow monitoring stations (Section 23 09 23)

3.15 PROJECT CLOSEOUT/OPERATION AND MAINTENANCE TRAINING

A. General
1. Two (2) training sessions shall be scheduled. The first shall occur after final inspection and prior to substantial completion. The second shall occur prior to the end of the first year of operation after acceptance. Training sessions shall be scheduled with the owner a minimum of two (2) weeks in advance.
2. Instruct the Owner’s representative(s) in operation and maintenance of Division 23 systems utilizing Operation and Maintenance Manual.
3. Individuals present shall include the Division 23 contractors, subcontractors and equipment factory representatives as appropriate. Certified factory representatives shall be present for all equipment requiring certified factory start-up.
4. The contractor’s representative performing the operation and maintenance training shall locate in the building each piece of equipment included in the O&M manuals, and shall instruct to the satisfaction of the owner’s representative required operation and maintenance procedures as outlined in the O&M manuals.
5. Provide a digital video of the training sessions conducted and furnish copies of the video to the Owner. Digital videos shall be of sufficient quality to allow training of future employees or refresher training of personnel. Use a virtual format, allowed by the Owner.

6. Training shall occur after final inspection and prior to acceptance by owner. It shall be scheduled with the owner, and shall occur in one consolidated session for all Division 23 equipment.
   a. Exceptions:
      1) Training for equipment requiring certified factory start-up shall be conducted at the time of start-up.
      2) Multiple sessions shall be scheduled as required to maintain a maximum allowable duration of any single session of four (4) hours.
      3) When separate training sessions are warranted to achieve proper training on all equipment and systems, as determined by the owner's representative, multiple sessions shall be scheduled as required.
      4) EMCS system training shall occur independently, and shall be in accordance with the requirements of Section 23 09 23.
      5) Training session shall include all equipment included in the table at the end of this section. A table similar to this one shall be used to verify owner training has been completed on all equipment, and shall be included in the Operation and Maintenance Manual.
7. A second training session shall occur prior to the end of the first year of operation after acceptance. Prior to this session, the owner shall submit a list of items to be covered. This session shall include all parts of the first training session necessary to meet the satisfaction of the owner, up to and including full training of all equipment and systems.

3.16 PROJECT CLOSEOUT/SPARE PARTS/MAINTENANCE MATERIALS

A. A list of spare parts to be provided under this contract has been included at the end of this section. Refer to individual specification sections for specific requirements of spare parts to be furnished under this contract.

B. Turn spare parts and materials over to Owner.

C. Provide summarized list of spare parts that have been furnished. List shall include verification by owner's representative that parts have been furnished. Incorporate into O&M Manual. Spare parts list shall be similar to that provided at the end of this section.

3.17 PROJECT CLOSEOUT/96-HOUR RUN TEST

A. The 96-hour test run shall be made when all field equipment is installed and the system is calibrated and running, and when all other building systems (including drywall, windows, doors, etc.) are complete. This period is intended to demonstrate the operation of the complete building.

B. The 96-hour run test shall include performance of all associated software and hardware operations called for in these specifications. The test shall be for a duration of 96 continuous hours with no Contractor maintenance required. The pre-balance conference shall not be scheduled until this test has been completed

satisfactorily (i.e. run without errors or alarms for a continuous 96-hour period). Notify owner's representative prior to beginning the 96-hour run test.

3.18 PROJECT CLOSEOUT/PRE-BALANCE REQUIREMENTS (REFER TO SECTION 23 05 93).

A. Provide Balance Agency with four (4) weeks written notice prior to start of Balance.

B. Pre-Balance Conference:
1. Prior to commencing Balancing, assemble the following parties at the project site for a pre-balance conference.
   a. General Contractor
   b. Plumbing Foreman
   c. Sheet Metal Foreman
   d. Control Technician
   e. Electrician
   f. Balance Agency
   g. Commissioning Agent
   h. Owner's Representative
2. Submit a pre-balance checklist similar to the table at the end of this section to the Balancing Agency and the Owner's Representative at the time of the pre-balance conference indicating that the system is ready for balance. The table at the end of this section shall be referenced for the minimum amount of information to be included in this checklist.
3. Should it be determined at the Pre-Balance Conference that the systems are not ready for balance, the balance shall be re-scheduled and the Owner's Representative shall be reimbursed for their travel cost and time at their normal hourly rates.
4. The Contractor shall make adjustments and changes in fan sheaves, belts, dampers and valves as required to achieve correct balance as recommended by the Balancing Agency at no additional cost to the Owner.

C. The Contractor shall furnish the Balance Agency with a complete set of Contract Documents including drawings, specifications, shop drawings and change orders pertinent to testing and balancing.

D. The Contractor shall perform the following tasks and provide the following items to the Balance Agency:
1. The Contractor shall put heating, ventilating, and cooling systems and equipment into full operation and continue their operation during each working day of testing and balancing for the Balancing Agency.
2. The Contractor shall make the sheet metal foreman and control contractor available upon request to aid in troubleshooting for the Balancing Agency.
3. The Contractor shall furnish all scaffolding, ladders, and access tools for the Balancing Agency.
4. Make adjustments and changes in fan sheaves, belts and dampers as required to achieve correct balance as recommended by the Balance Agency at no additional cost to the Owner.

5. Arrange access to all dampers, valves, balancing devices and operating equipment during the time that testing and balancing is to be performed.

E. The Control Contractor shall instruct the Balance Agency in the proper procedure for setting the controls, and provide a lap computer for accessing the control system. Upon completion of Balance, the laptop shall become the property of the Control Contractor.

F. The Control Contractor shall allow time for a control technician to assist the Balancing Agency.

3.19 PROJECT CLOSEOUT/WARRANTIES

A. Provide specific equipment/material warranties that extend beyond 1 year project warranty period.
   1. Refer to individual specifications sections for required extended warranties.
   2. Incorporate extended warranties into O&M Manual in warranties section.

3.20 PROJECT CLOSEOUT/FINAL CLEANING

A. Clean up all equipment, materials, cartons and other debris that is a direct result of the installation of equipment under this contract.

B. Clean exposed piping, ductwork and equipment. Repair damaged finishes and leave everything in working order.

3.21 PROJECT CLOSEOUT/RECORD DRAWINGS

A. Provide in accordance with Division 01 and the requirements of this section.

B. Record differences between mechanical work as installed and as shown in Contract Documents on a set of prints of mechanical drawings to be furnished by Owner's Representative. Return these prints to Owner's Representative at completion of Project. Notations made on drawings shall be neat and legible. These drawings shall not be used for any other purposes.
   1. Coordination drawings and fabrication drawings may not be utilized as record drawings unless
      a. Content from original drawings set such as notes and keynotes are transferred over to the coordination and fabrication drawings
      b. Drawings shall not be multidiscipline (i.e. plumbing and HVAC on same sheet) unless prepared that way in the construction documents.
      c. Drawings clearly identify deviations/modifications to the construction documents

C. Refer to individual specification sections for additional requirements.

3.22 PROJECT CLOSEOUT/PUNCH LIST PROCEDURES

A. The Contractor shall notify the Owner's Representative in writing when the project is ready for punch lists. The following items must be complete before punch list will be performed, and must be provided with written verification:
   1. Systems are complete and functional, including temperature controls.
   2. Testing and balancing is complete, and test and balance reports have been submitted for review.
   3. Operation and Maintenance Manuals are complete, and have been submitted for review.

B. After punch lists are complete, written notice must be forwarded to the Owner's Representative requesting final checkout. Any additional trips beyond the final checkout required due to incomplete items on previous punch lists will be billed to the Contractor at normal rate plus travel expenses.

C. At the time of initial and final observation, the project foreman shall accompany the observation party and shall remove access panels and perform other duties, as required, to allow complete observation of the entire Division 23 system.

3.23 PROJECT CLOSEOUT/MAINTENANCE SERVICES

A. Provide a separate manual describing specific maintenance services to be provided under this contract as required under specific specification sections.

PART 4 - TABLES

4.1 COST BREAKDOWN

A. Provide breakdown for the categories that follow. Each category shall identify separate costs for material and labor/installation.

B. Category:
   1. Mobilization
   2. Supervision
   3. Site Utilities
   4. Boilers
   5. Mini Split Units
   6. Chemical water treatment
   7. HVAC Piping equipment: water pumps, air separators, expansion tanks etc.
   8. HVAC Piping
   9. HVAC Piping Insulation
   10. Air Handling Units
   11. Terminal Heat Transfer Units
   12. Air Outlets and Inlets
   13. Ductwork Fabrication
   14. Ductwork Installation

15. Duct External Insulation
16. Air Terminal Units
17. EMCS Programming and Submittals
18. EMCS Equipment
19. Air and Water Balance
20. Commissioning Assistance

4.2 SPARE PARTS LIST

A. Section 23 05 19, Gauges
   1. Test kit

B. Section 23 21 23, Pumps
   1. One (1) set of mechanical seals for each pump

C. Section 23 34 00, HVAC Fans
   1. One (1) spare set of belts for each fan at project closeout

D. Section 23 40 00, Air Cleaning Devices
   1. One (1) spare set of filters for each filter bank

4.3 PRE-BALANCE CHECKLIST

Pre-Balance Checklist	
Item	**Complete**
General Contractor	
All doors and closures, windows and ceiling tile shall be installed	
96-hour run test complete	
Piping Contractor:	
All valves, flow meters, temperature/pressure taps installed correctly, functional and accessible	
Strainers and piping, clean, flushed, and free of debris	
Construction strainer baskets replaced with permanent baskets	
System filled to proper level and pressure reducing valve set	
Automatic and manual air vents properly installed and functional	
All air purged from system	
Water in expansion tanks at proper level	
All coils piped correctly and accessible	
Correct pump rotation	
Pumps properly aligned, grouted, and anchored	
Vibration isolators properly installed and adjusted	
Service and balance valves are open	

Pre-Balance Checklist	
Item	**Complete**
Sheet Metal Contractor	
Ductwork is intact and properly sealed	
Ductwork leak tested and repaired as required	
Access doors installed and properly secured	
Ductwork end caps installed	
Ductwork installed according to drawings and specifications	
Ductwork is free of debris	
All dampers, fire, volume, mixing, splitters are installed, accessible and open	
All terminal boxes, reheat coils, operators and dampers are installed, accessible and operable	
Return air has unobstructed path from each conditioned space back to the unit	
All grilles, registers, diffusers and other devices are installed and functional	
Filters are clean and correctly installed	
Filter frames correctly installed and sealed	
Coils clean, properly installed and sealed	
Drive components installed	
Sheaves properly aligned and tight on their shaft	
Belts adjusted for correct tension	
Belt guard properly installed	
Automatic control dampers installed and functional	
Fan rotation correct	
Fan housing installed and sealed	
All flex connections and vibration isolators are installed correctly	
Fan wheel aligned with adequate clearance	
Fan bearings lubricated	
Controls Contractor	
Controls complete and functional	
Thermostats and sensors calibrated	
Program correct and functional	

Pre-Balance Checklist	
Item	**Complete**
Electrical Contractor	
Motors wired and energized	
Proper starter and overload protection installed	
Correct fuses installed	
Motor secured to frame	
Motor bearings lubricated	
Fire alarms and duct smoke detectors are fully operational	

General Contractor Sign-Off: _____ Date: _____

Piping Contractor Sign-Off: _____ Date: _____

Sheet Metal Contractor Sign-Off: _____ Date: _____

Controls Contractor Sign-Off: _____ Date: _____

Electrical Contractor Sign-Off: _____ Date: _____

END OF SECTION

SECTION 23 05 13

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Common requirements for electric motors furnished on equipment specified in other Sections, including single phase and three phase electric motors.

1.2 RELATED SECTIONS

A. All mechanical sections with motor driven equipment

B. Section 23 05 00 – Common Work Results for HVAC

C. Section 23 09 23 – Direct-Digital Control for HVAC

D. Section 23 09 95 – Variable Frequency Drives

1.3 REFERENCES

A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings

B. NEMA MG 1 - Motors and Generators

C. NFPA 70 - National Electrical Code

1.4 REGULATORY REQUIREMENTS

A. Conform to UL Component Recognition for appropriate sizes

B. Conform to NFPA 70 and applicable State energy code

1.5 DELIVERY, STORAGE, AND HANDLING (REFER TO SECTION 23 05 00)

A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

PART 2 - PRODUCTS

2.1 MANUFACTURERS (REFER TO SECTION 23 05 00):

A. Century

B. Baldor

C. Marathon

D. General Electric

E. Westinghouse

2.2 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Motors less than 250 Watts, for intermittent service: Equipment manufacturer's standard and need not conform to these specifications.

B. Motors which are to be controlled from a variable frequency drive shall be designed and constructed for full compatibility with the drive.

C. Electrical Service:
1. Unless indicated otherwise on equipment schedules, motors shall be supplied as with the following electrical characteristics:
   a. Motors ½ horsepower and smaller: 115 single phase, 60 Hz
   b. Motors larger than ½ horsepower shall be three phase and shall be rated as specified and scheduled

D. Design for continuous operation in 104 °F environment.

E. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.

F. Visible Nameplate: Indicating manufacturer's name and model number, motor horsepower, RPM, frame size, voltage, phase, cycles, full load amps, insulation system class, service factor, maximum ambient temperature, temperature rise at rated horsepower, minimum efficiency.

G. Efficiency
1. All motors shall meet or exceed minimum efficiency requirements of the State Energy Code.
2. ECM motors shall have a minimum motor efficiency of 70% when rated in accordance with DOE 10 C.F.R 431.
3. Design A and B squirrel-cage T-frame induction permanently wired three phase motors of 1 HP or more shall be "premium efficient" and shall have a nominal full-load motor efficiency no less than the corresponding values for energy efficient motors provided in NEMA standard MG-1. Exceptions:

a. Motors installed in space conditioning equipment that have certified SEER /EER levels. This exception is to be utilized for electrically operated unitary air conditioners and condensing units as identified in the State Energy Code.

H. Invertor Duty Motors (For Use with Variable Frequency Drives):
1. Provide where scheduled on the drawings
2. Motors shall meet NEMA MG-1 Part 31 requirements. Nameplates shall state motors are “invertor duty”. Motors shall be suitable for variable torque and have a 10:1 speed ratio.
3. Critical vibration frequencies are not within operating range of controller output.
4. Temperature rise: Class B at rated full load.
5. Insulation: Minimum Class F
6. Provide with shaft grounding rings. Aegis or approved equal.

I. Wiring Terminations:
1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
2. For fractional horsepower motors where connection is made directly, provide conduit connection in end frame.

2.3 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

A. Starting Torque: Exceeding one fourth of full load torque

B. Starting Current: Up to six times full load current

C. Multiple Speed: Through tapped windings

D. Open Drip-proof and Enclosed Air Over Enclosure: Class F insulation, rated for 311 °F maximum temperature, NEMA Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.

2.4 SINGLE PHASE POWER - CAPACITOR START MOTORS

A. Starting Torque: Three times full load torque

B. Starting Current: Less than five times full load current

C. Pull-up Torque: Up to 350 % of full load torque

D. Breakdown Torque: Approximately 250 % of full load torque

E. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.

F. Drip-proof and Enclosed Motor Enclosures: Class F insulation, rated for 311 °F maximum temperature, NEMA Service Factor, prelubricated sleeve or ball bearings.

2.5 ELECTRICALLY COMMUTATED MOTORS (ECM) SINGLE AND THREE PHASE POWER

A. ECM motors shall be variable-speed, DC, brushless motors specifically designed for use with single phase, 277 volt (or 120 volt), 60 hertz electrical input. Motor shall be complete with and operated by a single-phase integrated controller/inverter that operates the wound stator and senses rotor position to electronically commutate the stator. All motors shall be designed for synchronous rotation. Motor rotor shall be permanent magnet type with near zero rotor losses. Motor shall have built-in soft start and soft speed change ramps.

B. Motor shall be able to be mounted with shaft in horizontal or vertical orientation. Motor shall be permanently lubricated with ball bearings. Motor shall be direct coupled to the blower. Motor shall maintain a minimum of 70% efficiency over its entire operating range. Provide manual (or optional remote) fan speed output control for field adjustment of the flow setpoint. Inductors shall be provided to minimize harmonic distortion and line noise. Provide isolation between motor assembly and unit casing to eliminate any vibration from the fan/motor to the equipment casing. Provide a motor that is designed to overcome reverse rotation and not affect life expectancy.

C. The equipment manufacturer shall provide a factory installed PWM controller for either manual or DDC controlled flow adjustment. The manual PWM controller shall be field adjustable with a standard screwdriver. The remote PWM controller shall be capable of receiving a 0-10 Vdc signal from the DDC controller (provided by the controls contractor) to control the flow. When the manual PWM controller is used, the factory shall preset the flow as shown on the schedule.

2.6 THREE PHASE POWER - SQUIRREL-CAGE MOTORS

A. Starting Torque: Between 1 and 1½ times full load torque

B. Starting Current: Six times full load current

C. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics

D. Design, Construction, Testing, and Performance: Conform to NEMA MG 1 for Design B motors

E. Insulation System: NEMA Class F or better

F. NEMA Service Factor

G. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.

H. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum AFBMA 9, L-10 life of 200,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

I. Sound Power Levels: To NEMA MG 1

2.7 ENCLOSED MOTOR CONTROLLERS (MOTOR STARTERS)

A. Enclosed Motor Controllers (starters) and switches are not under Mechanical unless specifically specified with a particular mechanical equipment item.
   1. Exception: Variable frequency drives furnished under Section 23 09 23.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.

B. Check line voltage and phase and ensure agreement with nameplate.

C. Motor starters and disconnects are not installed or furnished under Mechanical unless specified or scheduled to be factory furnished and mounted with a particular mechanical equipment item. Starters which are furnished with a particular mechanical equipment item but are shipped loose are not installed or wired under Mechanical.

D. Variable frequency drives are furnished by Section 23 09 23 in accordance with Section 23 09 95, with installation and power wiring by Division 26. Install shaft grounding rings on all VFD controlled motors.
   1. Exception: Drives shall be factory furnished, mounted and wired by associated equipment manufacturer when specified.

E. Application
   1. Open drip-proof enclosures (ODP) except where specifically noted otherwise.
   2. Totally enclosed fan cooled (TEFC) where exposed to weather or moisture.
   3. Unless scheduled otherwise on the drawings, provide the following motor types:
      a. Fan motors between 1/12 hp and 1 HP shall be provided with ECM motors. Provide with controls for balancing or for remote control operations as indicated in the control drawings.
      b. Exceptions:
         1) Belt driven fans may use sheave adjustments for airflow balancing if not specified/scheduled to have variable frequency drives.
         2) Motors in the airstream of heating terminal units that only operate when providing heat to the space served.
         3) Motors installed in space conditioning equipment that have certified SEER /EER levels as specified in the State Energy Code.
      c. Single phase fans and blowers (shaft mounted) that do not fall under the ECM requirements above shall be permanent split capacitor type.
      d. Single phase fans (non-shaft mounted), pumps, and air compressors that do not fall under ECM requirements above shall be capacitor start type.
      e. Three phase motors that do not fall under ECM requirements shall be squirrel-cage type

F. NEMA Open Motor Service Factor Schedule

HP	1800 RPM Motor
1/6 to 1/3	1.35
½ to ¾	1.25
1 to 150	1.15

END OF SECTION

SECTION 23 05 16

EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Manufactured Pipe Expansion Loops

1.2 RELATED SECTIONS

A. Section 23 05 00 – Common Work Results for HVAC

B. Section 23 07 00 – HVAC Insulation

C. Section 23 21 13 – Hydronic Piping

1.3 SUBMITTALS FOR REVIEW (REFER TO SECTION 23 05 00)

A. General: Component construction materials and methods; dimensions.

B. Manufactured Pipe Expansion Loops: Rigid and flexible pipe materials and construction; configuration; temperature and pressure rating of equipment; performance characteristics including expansion and contraction capabilities, manufacturer's special required procedures and external controls.

1.4 OPERATION AND MAINTENANCE MATERIALS (REFER TO SECTION 23 05 00)

A. General: Include equipment adjustment instructions.

1.5 DELIVERY, STORAGE, AND HANDLING (REFER TO SECTION 23 05 00)

A. Protect equipment from exposure by leaving factory coverings, pipe end protection, and packaging in place until installation.

PART 2 - PRODUCTS

2.1 PIPE EXPANSION LOOPS - HYDRONIC

A. Manufacturers (Refer to Section 23 05 00):
1. Hyspan
2. Mason
3. Metraflex

B. Basis of Design: Metraflex V-Loop Expansion Joint

C. Construction: Pipe materials of construction and fitting type shall be consistent with pipe material and equipment/pipe connection fittings. Rigid pipe and connections shall meet the requirements of the piping system in which the expansion loop is being installed; stainless steel inner hose and double-braided outer sleeve flexible pipe for steel piping systems; bronze inner hose and braided bronze outer sleeve flexible pipe for copper piping systems; 150 psig design pressure; 225 psig test pressure; 850 °F maximum working temperature.

D. Flexible loops shall impart no thrust loads to system support anchors or structure.

E. Configuration Option 1: Two flexible pipe sections connected with a 180° bend at one end and provided with a 90° elbow at the other end of each of the flexible pipe sections. Option 2 is for two flexible piping sections connected with a 90° bend at one end provided with a 45° elbow at the other end of each of the flexible pipe sections. The Contractor shall have the ability to utilize either option. Option 2 is shown on the drawings. Exceptions:
   1. Configuration shall be different when required by the specific installation (i.e. when installed at a 90° bend in the piping system, which would require 135° bends in lieu of 90° bends).
   2. Nested configurations may be utilized in parallel pipe runs to keep all expansion/seismic devices in one location. Nested configurations require (2) 90° bends with straight pipe in a loop fashion in lieu of the 180° bend.

F. Provide with drain/air release plug on 180° bend.

G. Factory supplied center support nut or bracket.
   1. Install in accordance with the manufacturers' written instructions.
   2. Install in a neutral, pre-compressed or pre-extended condition as required for the application.'

H. When spanning a building seismic expansion joint, guides and anchors are not required.

2.2 PIPE EXPANSION LOOPS - REFRIGERANT

A. Manufacturers (Refer to Section 23 05 00):
   1. Hyspan
   2. Mason
   3. Metraflex

B. Basis of Design: Metraflex VRF Metraloop

C. Contractor shall confirm with split system manufacturer that expansion loop is compliant with system requirements.

D. Construction: Pipe materials of construction and fitting type shall be consistent with pipe material and equipment/pipe connection fittings. Rigid pipe and connections shall meet the requirements of the piping system in which the expansion loop is being installed; 304 stainless steel inner hose and double-braided outer sleeve flexible pipe for steel piping systems; 304 stainless steel to copper adapter on both sides of expansion joint; 304

stainless steel schd. 40 long radius elbows; 700 psig design pressure; 300 °F maximum working temperature; rated for full vacuum.

E. Flexible loops shall impart no thrust loads to system support anchors or structure.

F. Configuration Option 1: Two flexible pipe sections connected with a 180° bend at one end and provided with a 90° elbow at the other end of each of the flexible pipe sections. Option 2 is for two flexible piping sections connected with a 90° bend at one end provided with a 45° elbow at the other end of each of the flexible pipe sections. The Contractor shall have the ability to utilize either option. Option 2 is shown on the drawings. Exceptions:
   1. Configuration shall be different when required by the specific installation (i.e. when installed at a 90° bend in the piping system, which would require 135° bends in lieu of 90° bends).
   2. Nested configurations may be utilized in parallel pipe runs to keep all expansion/seismic devices in one location. Nested configurations require (2) 90° bends with straight pipe in a loop fashion in lieu of the 180° bend.

G. Factory supplied center support nut or bracket.
   1. Install in accordance with the manufacturers' written instructions.
   2. Install in a neutral, pre-compressed or pre-extended condition as required for the application.'

H. When spanning a building seismic expansion joint, guides and anchors are not required.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide in accordance with manufacturer's instructions.

3.2 PIPE EXPANSION LOOPS

A. Provide at each pipe penetration of the building seismic/expansion joint.

B. Loops pipe diameter shall be same as connecting pipe.

C. Install in a neutral, pre-compressed or pre-extended condition as required for the application.

D. Rigidly support pipe on either size of loop on each side of the seismic joint in accordance with the manufacturer's requirements.

E. Prior to preparation of submittals and ordering, contractor shall coordinate available space and provide over/under loops, nested loops, vertical or horizontal loops as required to fit within available space. Submittals shall indicate configuration.

END OF SECTION

SECTION 23 05 17

SLEEVES AND SLEEVE SEALS FOR HVAC

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Flashing

B. Sleeves

1.2 RELATED SECTIONS

A. Division 3 – Cast-In-Place Concrete

B. Division 7 - Thermal and Moisture Protection

C. Section 23 05 00 – Common Work Results for HVAC

D. Section 23 05 48 – Vibration Isolation

E. Section 23 07 00 – HVAC Insulation

F. Section 23 21 13 – Hydronic Piping

G. Section 23 23 00 – Refrigerant Piping

H. Section 23 31 00 – HVAC Ducts and Casings

1.3 SUBMITTALS FOR REVIEW (REFER TO SECTION 23 05 00)

A. Product Data: Provide manufacturers catalog data

B. Manufacturer's Installation Instructions: Indicate special procedures and assembly of components.

PART 2 - PRODUCTS

2.1 FLASHING

A. Roof Flashing
   1. Flashing materials shall be coordinated and approved by the roof manufacturer and not alter the roof warranty.
   2. Product may include:
      a. SBC Industries Line Shack Model "LS"

b. The SBC Line Shack is a pipe box designed to house and flash A/C lines, refrigerant tubing, and flexible conduit through the roof while allowing access with a slide top. The Line Shack will accommodate refrigerant tubing and conduit for up to four A/C units.
   1) Metal: 26 ga Stainless Steel, type 304, 2B finish ASTM A240
   2) Solder: 50/50 (lead/tin) ASTM B32
   3) Neoprene: Closed cell block foam

2.2 SLEEVES

A. Sleeves for Pipes through Non-fire Rated Floors: 18 gauge thick galvanized steel.

B. Sleeves for Pipes through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gauge thick galvanized steel.

C. Sleeves for Pipes through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed, refer to Division 7.

D. Sleeves for Round Ductwork: Galvanized steel.

E. Sleeves for Rectangular Ductwork: Galvanized steel.

F. Stuffing Insulation: Glass fiber type; non-combustible; 3 lb. density.

G. Fire Safeing Sealant: Intumescent material capable of expanding up to 8 to 10 times when exposed to temperatures beginning at 250 °F. It shall have ICBO, BOCA I approved ratings to 3 hours per ASTM E814 (UL 1479). 3M Fire Barrier Caulk, Putty, strip and sheet forms. Refer to Division 7.

PART 3 - EXECUTION

3.1 GENERAL

A. Install in accordance with manufacturer’s instructions.

3.2 FLASHING

A. Flashing shall be coordinated with roofing system requirements and shall suit style and type of roofing used. All roof flashing shall be approved by the roof material contractor and be compatible with the roofing system warranty. Install in accordance with the roofing manufacturer’s recommendations.

B. Counterflashing for all roof mounted mechanical equipment shall be the responsibility of this Contractor and shall be completely coordinated with the Contractor providing curbs and roofing.

C. Provide curbs for mechanical roof installations 12 inches minimum high above roofing surface unless otherwise indicated. Flash and counterflash with sheet metal; seal

watertight. Attach counterflashing mechanical equipment and lap base flashing on roof curbs. Flatten and solder joints.

D. Adjust storm collars tight to pipe with bolts; calk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

E. Provide SBC Industries line shack model LS where indicated on the drawings. Flash the line shack to the roof to achieve a watertight installation, in accordance with the roofing manufacturer's recommendations.

3.3 SLEEVES

A. Provide sleeves for above grade duct and piping penetrations of walls, roofs and floors.

B. Duct sleeves shall be 18 gauge galvanized steel.

C. Set sleeves in position in formwork. Provide reinforcing around sleeves.

D. Size sleeves large enough to allow for movement due to expansion and contraction but not less than (2) pipe sizes larger than piping run. Provide for continuous insulation wrapping, where required.

E. Where piping or ductwork penetrates a roof, floor or wall, close off space between pipe or duct and sleeve with 3 lb. Fiberglass insulation and elastomeric, acoustical Sealant (air tight). Provide backer rod as necessary. This applies to all roofs, walls or floors regardless of fire rating.

F. Provide chrome plated cast brass, one piece escutcheons at all pipe penetrations of finished surfaces (walls, ceilings, floors). Provide security set screw.

G. Sleeves are not required for core drilled holes.

END OF SECTION

SECTION 23 05 19

METERS AND GAUGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Pressure Gauges (Hydronic Service)

B. Pressure Gauge Tappings

C. Stem Type Thermometers and Supports

D. Test Plugs and Kits

1.2 RELATED SECTIONS

A. Section 23 05 00 – Common Work Results for HVAC

B. Section 23 09 23 – Direct-Digital Control for HVAC

C. Section 23 21 13 – Hydronic Piping

D. Section 23 23 00 – Refrigerant Piping

1.3 REFERENCES

A. Pressure Gauges
   1. ASME B40.1 - Gauges - Pressure Indicating Dial Type - Elastic Element

1.4 SUBMITTALS FOR REVIEW (REFER TO SECTION 23 05 00)

A. General
   1. Provide manufacturers data which indicates use, construction, operating range, total range, accuracy, and dimensions.
   2. Provide a Gauge Application Table indicating each different use of gauges and the gauge range to be utilized, including minimum and maximum measurement values.

1.5 OPERATION AND MAINTENANCE MATERIALS (REFER TO SECTION 23 05 00)

A. General: Include instructions for calibrating instruments.

1.6 PROJECT RECORD DOCUMENTS

A. Record actual locations of components and instrumentation.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Do not install instruments when areas are under construction, except for required rough-in, taps, supports and test plugs.

1.8 EXTRA MATERIALS

A. Test kit

PART 2 - PRODUCTS

2.1 PRESSURE GAUGES (HYDRONIC SERVICE)

A. Manufacturers (Refer to Section 23 05 00):
1. Trerice
2. Weiss
3. Weksler
4. Tel Tru
5. Miljoco

B. Basis of Design: Trerice Series 600CB

C. Construction: ASME B40.1; 4½ inch dial; cast aluminum case; brass tube and socket; brass movement; painted aluminum dial with black graduations on white background; suitable for outdoor use; psi scale as appropriate for intended use; full scale accuracy of plus or minus 1 %.

2.2 PRESSURE GAUGE TAPPINGS

A. ¼ inch NPT brass ball valve rated for 250 psig; brass pressure snubber with ¼ inch NPT connections.

2.3 STEM TYPE THERMOMETERS AND SUPPORTS

A. Manufacturers (Refer to Section 23 05 00):
1. Duro
2. Trerice
3. Weiss
4. Weksler
5. Tel Tru
6. Miljoco

B. Basis of Design: Trerice Series BX9

C. Construction: Nine (9) inch high, adjustable angle; blue colored organic spirit; lens front tube; UV protected clear acrylic window up to 300 °F and double strength above 300 °F; ¾ inch long NPT brass stem with 2½ inch insertion length; cast aluminum case with enamel or epoxy finish; cast aluminum adjustable joint with positive locking device; scale to suit application; well to suit service; full scale accuracy within 2 %; Fahrenheit scale as appropriate for intended use.

D. Supports: Brass separable sockets for thermometer stems with or without extensions as required.

2.4 TEST PLUGS AND KITS

A. Test Plug:
1. Manufacturers (Refer to Section 23 05 00):
   a. Flow Design
   b. MG Piping Products
   c. Pete's Plugs
   d. Sisco
   e. Trerice
2. Construction: ¼ inch NPT or ½ inch NPT brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with neoprene core for temperatures up to 200 °F; nordel core for temperatures up to 350 °F; viton core for temperatures up to 400 °F; brass extension for insulated pipe.

B. Test Kit:
1. Manufacturers: Same as noted above for Test Plugs.

C. Test Kit:
1. Manufacturers: Same as noted above for Test Plugs.
2. Internally padded and fitted carrying case;
   a. Brass gauge adaptor with probe
   b. (1) dial face thermometer for 25-125 degree range
   c. (1) dial face thermometer for 0-220 degree range
   d. (1) pressure gauge for 0-100 psi

2.5 HYDRONIC FLOW METERS

A. Water flow and energy meters for use in Hydronic Systems are furnished in Section 23 09 23.

PART 3 - EXECUTION

3.1 GENERAL

A. Install in complete conformance with the manufacturer's instructions.

B. Coil and conceal excess capillary on remote element instruments.

C. Provide instruments with scale ranges selected according to service with largest appropriate scale.

D. Install gauges and thermometers in locations where they are easily read from normal operating level without crawling or climbing. Install vertical to 45 degrees off vertical.

E. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.

3.2 PRESSURE GAUGES

A. Provide pressure gauges where indicated on plans.

B. Install pressure gauges with snubbers. Provide ball valve to isolate each gauge. Install syphon on gauges in steam systems. Extend nipples and syphons to allow clearances from insulation.

C. Install one pressure gauge per pump, (whether indicated on the drawings or not), with taps and isolation valves. Points of connection shall be before strainers and on suction and discharge of pump; pipe to gauge.

3.3 PRESSURE GAUGE TAPPINGS

A. Install gauge taps/test plugs in piping; refer to related piping specifications sections.

B. At minimum, provide gauge taps/test plugs for the purposes of calibration of gauges and thermometers installed in this section and calibration of sensors installed for the Energy Management and Direct Digital Control System in Section 23 09 23.

C. Where gauges and sensors are located at the same hydraulic and thermal point in the piping system (i.e. a pressure gauge, temperature gauge and Section 23 09 23 located together) a single test plug may be provided.

D. Provide gauge taps/test plugs as follows:
   1. Adjacent to pressure gauges
   2. Adjacent to thermometers
   3. Adjacent to pressure and temperature sensors provided in Section 23 09 23
   4. Inlet and outlet of coil or equipment where pressure and temperature gauges are not furnished.
   5. Where indicated on drawings.

3.4 STEM TYPE THERMOMETERS AND SUPPORTS

A. Provide thermometers where indicated on plans. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2½ inches for installation of thermometer sockets 24 inches on each side of the thermometer. Ensure sockets allow clearance from insulation.

3.5 TEST PLUGS AND KITS

A. Provide temperature and pressure test plugs where indicated on the plans.

B. Turn over test kit to the Owner at project closeout.

3.6 METERS

A. Install in accordance with the manufacturer's written requirements.

END OF SECTION

SECTION 23 05 23

GENERAL DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Access Doors

B. General Valves

1.2 RELATED SECTIONS

A. Division 8 – Access Doors

B. Division 9 – Painting

C. Section 23 05 00 – Common Work Results for HVAC

D. Section 23 05 53 – Identification for HVAC Piping and Equipment

E. Section 23 07 00 – HVAC Insulation

F. Section 23 21 13 – Hydronic Piping

1.3 GENERAL

A. All materials shall be compatible with ethylene and propylene glycol.

1.4 SUBMITTALS FOR REVIEW (REFER TO SECTION 23 05 00)

A. Product Data: Include data on valves and accessories. Provide manufacturer's catalogue information. Indicate valve data and ratings.

1.5 QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating marked on valve body.

1.6 PROJECT RECORD DOCUMENTS (REFER TO SECTION 23 05 00)

A. Record actual locations of valves and piping.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 23 05 00.

B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

C. Provide temporary protective coating on iron or steel valves.

D. Provide temporary end caps and closures. Maintain in place until installation.

PART 2 - PRODUCTS

2.1 ACCESS DOORS

A. Materials shall be in accordance with Division 8.

2.2 GENERAL VALVES

A. Manufacturers (Refer to Section 23 05 00):
1. Bray
2. Crane
3. Grinnell
4. Hammond
5. Jenkins
6. Milwaukee
7. Nibco
8. Powell
9. Stockham
10. Walworth
11. Watts

B. Ball Valves:
1. Up to and including 2 inch: Bronze, two piece body, chrome plated ball with standard port, teflon seat, and stuffing box ring, lever handle, solder or threaded ends with union, 600 psi WG. Provide with memory stops when used as a balancing cock.
   a. Basis of Design: Milwaukee BA-100S (threaded), Milwaukee BA-150S, (solder)

C. Butterfly Valves:
1. 2 inch and smaller: Bronze body; threaded or solder ends; Viton seat; stainless steel disk and stem; lever handle operator; memory stops when used as a balancing cock; 175 psi SWP
   a. Basis of Design: Milwaukee, Butterball BB2-100, threaded. Milwaukee, Butterball BB2-350, solder

PART 3 - EXECUTION

3.1 PREPARATION

A. Remove scale and dirt on inside and outside before assembly.

3.2 INSTALLATION – GENERAL

A. Provide valves as indicated on the drawings.

B. Valves shall be line size unless indicated otherwise.

C. Valves in mechanical spaces at a height greater than 8 feet shall be provided with gear operators and chain.

D. Install in accordance with manufacturer's instructions and as indicated on the drawings.

E. Provide access doors where valves and fittings are not exposed unless indicated to be provided under other divisions. Access doors shall comply with Division 8.

F. Install valves with stems upright or horizontal, not inverted.
   1. Where space allows, install butterfly valves in the horizontal position or rotated 45 degrees to prevent premature failure of the liner and accumulation of debris.

3.3 INSTALLATION – VALVES

A. Use ball or butterfly valves for shut-off and to isolate equipment, of systems, or vertical risers.

B. Use ball or butterfly valves for throttling, bypass, or manual flow control services.

C. Use lug end butterfly valves to isolate equipment.

D. Use ¾ inch ball valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment. Pipe to nearest floor drain.

END OF SECTION

SECTION 23 05 29

HANGERS AND SUPPORTS FOR HVAC PIPING AND FITTINGS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Equipment Curbs

B. Inserts

C. Pipe Hangers and Supports

D. Pipe Shields and Saddles

E. Resilient Clamps

F. Equipment Supports

1.2 RELATED SECTIONS

A. Division 3 - Cast-In-Place Concrete

B. Division 7 - Thermal and Moisture Protection

C. Section 23 05 00 – Common Work Results for HVAC

D. Section 23 05 48 – Vibration Isolation

E. Section 23 07 00 – HVAC Insulation

F. Section 23 21 13 – Hydronic Piping

G. Section 23 23 00 – Refrigerant Piping

H. Section 23 31 00 – HVAC Ducts and Casing

1.3 REFERENCES

A. General
   1. ASME B31.5 - Refrigeration Piping
   2. ASME B31.9 - Building Services Piping

B. Pipe Hangers and Supports
   1. ASTM F708 - Design and Installation of Rigid Pipe Hangers
   2. MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacturer
   3. MSS SP69 - Pipe Hangers and Supports - Selection and Application

4. MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices

1.4 SUBMITTALS FOR REVIEW (REFER TO SECTION 23 05 00)

A. Product Data: Provide manufacturers catalog data including load capacity.

B. Manufacturer's Installation Instructions: Indicate special procedures and assembly of components.

1.5 REGULATORY REQUIREMENTS

A. Pipe Hangers and Supports
1. Hanger and support systems shall conform to MSS SP58, MSS SP69, MSS SP89

PART 2 - PRODUCTS

2.1 EQUIPMENT CURBS

A. Equipment curbs indicated to be under Mechanical on mechanical equipment schedules and specified herein shall be factory fabricated and shall be of the same manufacturer as the supported equipment to ensure compatibility and size coordination. Reference associated equipment specifications and schedules for equipment curb requirements.

2.2 INSERTS

A. Construction: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment; top slot for reinforcing rods; lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.3 PIPE HANGERS AND SUPPORTS

A. Manufacturers (Refer to Section 23 05 00):
1. Grinnell/Anvil
2. ERICO/Michigan Hanger
3. Crane
4. Fee and Mason

B. Hydronic Piping
1. Conform to MSS SP58, MSS SP69, and MSS SP89.
2. Hangers for Pipe Sizes ½ to 2 inches: Carbon steel, adjustable swivel, split ring.
3. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
4. Wall Support for Pipe Sizes to 3 inches: Cast iron hook.
5. Vertical Support: Steel riser clamp.
6. Floor Support for Hot Pipes Sizes to 4 inches: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
7. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

C. Refrigerant Piping
   1. Conform to MSS SP58, MSS SP69, and MSS SP89.
   2. Hangers for Pipe Sizes ½ to 1½ inches: Carbon steel, adjustable swivel, split ring.
   3. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
   4. Vertical Support: Steel riser clamp.
   5. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
   6. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

D. Pipe Riser Clamps
   1. Steel and Cast Iron Pipe: Extension pipe or riser clamp; carbon steel; black or galvanized finish.
      a. Basis of design: Grinnell Fig 261.
   2. Copper Pipe: Copper tubing riser clamp; carbon steel; copper finish.
      a. Basis of design: Grinnell Fig CT-121.

2.4 HANGER RODS

A. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

2.5 PIPE SHIELDS AND SADDLES

A. Manufacturers (Refer to Section 23 05 00):
   1. Anvil
   2. Fee & Mason
   3. M-Co
   4. Pipe Shields, Inc
   5. Kin-Line

B. Hot Piping (up to 2”):
   1. Insulation protection shield type; carbon steel; galvanized finish; Anvil Fig 167.
   2. For vertical pipe hanger supports, the shields shall covering the lower 40% of the circumference of the insulation.
   3. For pipe installed on trapeze hangers, the shields shall extend to cover the full circumference of the pipe.
   4. Shield shall be sized to suite pipe insulation thickness. High density insert furnished in Section 23 07 00 and installed in this section.

2.6 RESILIENT CLAMPS

A. Refer to Section 23 05 48 for supplemental requirements for penetration isolation. In the event of a conflict, Section 23 05 48 shall take precedence.

B. Manufacturers (Refer to Section 23 05 00):
   1. Hydra-Zorb

C. Construction: Resilient cushion with clamps and anchoring channel.

2.7 ROOF PIPE SUPPORTS-STRUT CHANNEL SUPPORT STANDS

A. Manufacturers (Refer to Section 23 05 00)
   1. Unistrut Unipier Rooftop Pipe Support System
   2. MAPA
   3. Miro Industries

B. Polycarbonate base with carbon black pigment for UV resistance or stainless steel base as required for load. Rounded edges to prevent gouging of roof membrane.

C. Base for supports shall be single base required for weight/duty of pipe supports.

D. Support pad (minimum 1/8" thick) between base and roofing to protect roofing, maximum loading 5 psi.

E. Supports shall hot dipped galvanized and have adjustable heights. Heights shall allow for mounting of pipe, duct and equipment above snow levels. Supports shall allow for single or multiple pipes in for single tier or multiple tier installations

F. All thread shall be stainless steel with size to support weight of supported pipe, duct or equipment.

PART 3 - EXECUTION

3.1 GENERAL

A. Install in accordance with manufacturer's instructions.

B. Piping shall be installed in such a manner that it is not in contact with metal building components.

C. Provide neoprene or approved wrap between water piping and metal building components, unistrut or other metal.
   1. Exceptions:
      a. Not required where piping is isolated from hangers with insulation shields.
      b. Not required where resilient clamps are used.

D. Concrete housekeeping pads for mechanical equipment are not under Mechanical. Coordinate required location and size with other Divisions and provide equipment shop drawings for proper sizing.

E. Provide templates, anchor bolts, and accessories for mounting and anchoring to other Divisions as applicable.

F. Construct supports of steel members. Brace and fasten with flanges bolted to structure.

G. Provide rigid anchors for pipes after vibration isolation components are installed.

H. Provide factory pre-fabricated roof curbs (indicated on drawings and equipment schedules to be furnished under Mechanical) in accordance with the manufacturer's recommendations and as indicated on the drawings.

3.2 INSERTS

A. Provide inserts for placement in concrete formwork.

B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.

D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab in concealed areas and recessed into and grouted flush with slab in exposed areas.

3.3 PIPE HANGERS AND SUPPORTS

A. Support horizontal piping in accordance with applicable codes and the table at the end of this section.

B. Piping within the equipment room shall be vibration isolated in accordance with Section 23 05 48.

C. Install hangers to provide minimum ½ inch space between finished covering and adjacent work.

D. Place hangers within 12 inches of each horizontal elbow.

E. Use hangers with 1½ inch minimum vertical adjustment.

F. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.

G. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

H. Support riser piping independently of connected horizontal piping.

I. Provide copper plated hangers and supports for copper piping.

J. Design hangers for pipe movement without disengagement of supported pipe.

K. Prime coat exposed steel hangers and supports. (Refer to Division 9) Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

L. Support vertical piping at every floor penetration with pipe riser clamps.

M. Support risers independently of connected horizontal piping.

N. Provide vibration isolation at supports when required by Section 23 05 48.

O. Install piping on “Roof Pipe Supports”. See details on plans.

3.4 PIPE SHIELDS AND SADDLES

A. Provide shields and saddles to protect pipe insulation at hangers. (Furnished and installed under Section 23 05 29.)

B. Size hangers to accommodate pipe insulation and insulation shields where applicable. See Section 23 07 00.

3.5 PIPE INSULATION INSERTS

A. Furnished under Section 23 07 00, installed under Section 23 05 29.

3.6 RESILIENT CLAMPS

A. Use to attach tubing, pipe, or hoses to vibrating machinery or equipment.

B. Use to isolate piping from contact with other metals, steel partition studs.

3.7 EQUIPMENT SUPPORTS

A. Provide supports and attachments to structure as required for installation of equipment. Supports shall be for basemounted or suspended applications to suit project conditions or as indicated on drawings.

B. Supports shall comply with Section 23 05 48 and 23 05 49.

PART 4 - TABLES

Pipe Size inches	**Max. Horizontal Spacing for Hangers feet**		**Hanger Rod Dia. inches**
	Threaded or Welded Joints Steel (excluding gas)	**Copper Tube and Piping (soldered, brazed or welded joints)**	
½	10	6	3/8
¾	10	6	3/8
1	10	6	3/8
1¼	10	6	3/8

Pipe Size inches	**Max. Horizontal Spacing for Hangers feet**		**Hanger Rod Dia. inches**
	Threaded or Welded Joints	**Copper Tube and Piping (soldered, brazed or welded joints)**	
	Steel (excluding gas)		
1½	12	6	3/8
2 to 3	12	10	½
4 to 6	12	10	5/8
8 to 12	12	10	7/8
Notes: 1. Vertical piping shall be supported in accordance with tables 313.3 and 313.6 of the Uniform Plumbing Code as amended by Washington state.			

END OF SECTION

SECTION 23 05 48

VIBRATION ISOLATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Open Steel Spring Isolators

B. Restrained Spring Isolators

C. Spring and Neoprene Hangers

D. Neoprene Waffle Pads

E. Flexible Duct Connections

F. Flexible Pipe Connections

G. Vibration Isolated Roof Curbs.

1.2 RELATED SECTIONS

A. Division 03 - Concrete

B. Section 23 05 00 – Common Work Results for HVAC

C. Section 23 05 49 – Seismic Controls for HVAC

D. Division 23 piping, ductwork and equipment as specified herein.

1.3 REFERENCES

A. 1999 ASHRAE Handbook, Vibration Isolation

1.4 PERFORMANCE REQUIREMENTS

A. Provide minimum static deflection of isolators for equipment as indicated.
   1. 400 - 600 rpm: 3.5 inch
   2. 601 - 800 rpm: 2 inch
   3. 801 - 900 rpm: 1 inch
   4. 901 - 1500 rpm: 0.5 inch
   5. Over 1500 rpm: 0.2 inch

1.5 SUBMITTALS FOR REVIEW (REFER TO SECTION 23 05 00)

A. Product Information: Provide material and type of construction. Provide schedule of vibration isolator type with location and load on each.

B. Manufacturer's Installation Instructions: Indicate special procedures and setting dimensions.

PART 2 - PRODUCTS

2.1 GENERAL ISOLATORS

A. Manufacturers (Refer to Section 23 05 00):
1. Amber Booth
2. Kinetics
3. Korfund
4. Mason Industries
5. Isolators provided by the manufacturer of isolated equipment as an accessory to that equipment are acceptable when indicated in these specifications or on the drawings to be provided with isolation equipment as an accessory to the equipment.

B. Open Steel Spring Isolators: Adjustable, freestanding, open steel spring mounting with top and base plates designed to allow rigid attachment to the machinery frame and supporting structure, respectively. Used for equipment that does not encounter weight removal or wind loads. Neoprene pad must be located under the baseplate and not between the baseplate and spring. Spring shall provide an additional travel to solid distance equal to 50 % of the rate deflection.
1. Basis of Design: Mason Industries, type SLF.

C. Restrained Spring Isolators: Adjustable, open spring isolator, similar to Open Steel Spring, with a frame to include vertical resilient stops to prevent spring extension when weight is removed. For equipment whose operating weight may differ from isolated weight, mounts shall be designed with fail-safe feature to protect against wind loads and overturning of mounts in earthquakes. Mounts shall be capable of withstanding lateral accelerations of 1g. Allow ½ inch clearance around vertical restraining bolts, with neoprene grommets and washer to prevent restraining bolts from short circuiting isolation. Limit stops must be out of contact during normal operation. Springs shall provide an additional travel to solid distance equal to 50 % of the rated deflection.
1. Basis of Design: Mason Industries, type SLR

D. Spring and Neoprene Hanger: Spring and neoprene hanger consisting of a steel spring in series with a neoprene isolation element or neoprene hanger as scheduled with equipment to be isolated. Where not indicated, spring and neoprene hanger shall be used. Springs shall provide an additional travel to solid equal to 50 % of the rated deflection. Isolator assembly shall be designed to support five times overload without failure and allow up to 15 degrees of hanger rod misalignment. Hangers shall be attached directly to the structure with a single hanger rod making the balance of the connection.
1. Basis of Design: Mason Industries, type DNHS

E. Neoprene Hanger: Hangers shall consist of rigid steel frame containing a minimum 1-1/4" (32mm) thick LDS rubber element at the top and a steel spring with general characteristics as in specification B seated in a steel washer reinforced LDS rubber cup on the bottom. The LDS rubber element and the cup shall have molded bushings projecting through the steel box. In order to maintain stability the boxes shall not be articulated as clevis hangers nor the LDS rubber element stacked on top of the spring. Spring and hanger lower hole diameters shall be large enough to permit the hanger rod to swing through a 30° arc from side to side before contacting the cup bushing and short circuiting the spring.
   1. Basis of Design: Mason Industries, type HD

F. Neoprene Waffle Pads: Minimum ¾ inch thick; maximum loading 40 psi.
   1. Basis of Design: Mason SW

G. Neoprene Bushings: Minimum ¾ inch thick; maximum loading 40 psi.
   1. A one piece molded bridge bearing neoprene washer/bushing. The bushing shall surround the anchor bolt and have a flat washer face to avoid metal to metal contact.
   2. Basis of Design: Mason HG

2.2 FLEXIBLE DUCT CONNECTIONS

A. Manufacturers (Refer to Section 23 05 00):
   1. Ventfabrics
   2. Duro Dyne

B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.

C. Standard Connector: Fabric crimped into metal edging strip.
   1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 26 ounces/yard². Rated for -20 °F to 200 °F for standard, non-corrosive, indoor applications.

D. High temperature Connector: Fabric crimped into metal edging strip. For use in ECU systems.
   1. Fabric: UL listed fire-retardant teflon coated woven glass fiber fabric to NFPA 90A, minimum density 16.5 ounces/yard² (26 kg/m²). Rated for -150 °F to 500 °F (-29 °C to 93 °C) for standard, non-corrosive, indoor applications.

2.3 FLEXIBLE PIPE CONNECTORS

A. Flexible Pipe Connectors-Braided hose
   1. Hydronic piping
      a. Braided flexible stainless steel hose.
      b. Hose to be rated at a minimum of 250 psi at 250 degrees F.
      c. Hose to be installed horizontally and parallel to equipment shaft.
      d. Hose to have a minimum length of 18 inches.
      e. Hose for 2 inch pipe size and smaller to be equipped with male nipple fittings.
      f. Hose for 2½ inch pipe size and larger to be equipped with fixed steel flanges.

g. Hose to be selected for operating pressure with 4:1 minimum safety factor.
h. Acceptable Products:
   1) Model BSS by Mason
   2) Hyspan

2. Refrigerant piping
   a. Mason ULCPS or approved equal.
      1) Stainless steel braided hose with copper female sweat ends, UL approved for refrigerant service for pressures, temperatures and refrigerant type.

2.4 VIBRATION ISOLATED ROOF CURB

A. Curb mounted rooftop equipment shall be flexibly ducted, natural gas lines with flexible connectors, and electrical lines with flexible conduits. The units shall be supported by a spring isolation curb, the lower member of which is a rigid steel tube or a specially formed steel section containing adjustable and removable steel springs that support the upper floating section. The upper frame must provide continuous support for the equipment and must remain captive when resiliently resisting wind and seismic forces. All directional neoprene snubber bushings must be a minimum of 1/4” thick. Steel springs shall rest on 1/4” neoprene acoustical pads. Minimum spring deflection shall be or 2-1/2”. Hardware must be cadmium or zinc electroplated and the springs similarly plated or provided with an approved rust resistant finish.

B. The lower member shall consist of a sheet metal Z section containing adjustable and removable steel springs that support the upper floating section. The upper frame must provide continuous support for the equipment and must be captive so as to resiliently resist wind forces. All directional neoprene snubber bushings shall be a minimum of 1/4”(6mm) thick. Steel springs shall be laterally stable and rest on 1/4”(6mm) thick neoprene acoustical pads.

C. Hardware must be plated and the springs provided with a rust resistant finish. The curbs waterproofing shall consist of a continuous galvanized flexible counter flashing nailed over the lower curbs waterproofing and joined at the corners by EPDM bellows. All spring locations shall have access ports with removable waterproof covers.

D. The curb’s waterproofing shall consist of a continuous galvanized flexible counterflashing nailed over the lower curb’s waterproofing and joined at the corners by EPDM bellows. All spring locations shall have access ports with removable waterproof covers. Lower curbs shall have provision for 2” insulation.

E. Curb shall be insulated to the same thickness and overall R-value as the roof insulation.

F. Acceptable Products:
   1. Model RSC by Mason
   2. Model YW by Caldyn

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide and install in accordance with manufacturer's instructions.

B. Provide isolation for all motor driven equipment furnished in this project:
   1. Exceptions:
      a. In-line circulating pumps

C. Install spring hangers without binding.

D. Connect wiring to isolated equipment with flexible hanging loop.

E. Vibration Isolation Schedules:
   1. Flexible duct connectors:
      a. Provide at connections to all air moving equipment unless noted otherwise on the drawings.
      b. Ensure metal bands at connectors are parallel with minimum 1" flex between ductwork and the fan while running.
      c. Provide high temperature flexible duct connectors to all ECU fans.
   2. Neoprene pad:
      a. Provide continuous pad between each base mounted rail base and the floor/slab or housekeeping pad for base mounted equipment that is not mounted with external spring isolators.
      b. Equipment
         1) Make-Up Air Units
         2) Condensing Unit
         3) Gas Fired Unit Heaters
         4) Boilers
         5) Water Heaters
         6) In-line Pumps (P-1)
            a) P-1 is installed at 4'-0" AFF. Provide floor support below pump with neoprene pad.
   3. Neoprene bushings:
      a. Provide bushing between each pump support and the pump body at all bolts.
      b. Provide busing between each base mounted rail base and the floor/slab or housekeeping pad for base mounted equipment.
      c. Water Heater seismic strap shall be attached to the building structure with neoprene bushings to isolate strap from structure.
      d. Equipment
         1) In-line Pumps (P-1)
         2) Boiler
         3) Water Heater

   4. Spring and Neoprene Hanger
      a. Suspended indoor Fan Coil Units
      b. Suspended In-Line Pumps
      c. Exhaust Fans (1" minimum static deflection)
   5. Neoprene Hanger
      a. Fan Powered Variable Air Volume Terminal Units

6. Base mounted restrained spring isolators
   a. Provide for split system outdoor condensing units
   b. Provide for ECU fans.
7. Flexible piping connections:
   a. Provide braided hose connectors at all connections to split system condensing units. Piping connectors made with hose connection kits in Section 23 21 16 is exempt from this requirement.
   b. Provide braided hose connectors at all pipe connections to in-line pumps
   c. Drain piping is excluded from the above requirements.
8. Vibration Isolated Roof Curbs
   a. Roof mounted air handling units

F. All hydronic, domestic, and gas piping within 114 Equipment Room shall be isolated from structure with neoprene pads. For all unistrut, hangers, clevis, etc. utilized for piping hanging, provide a neoprene waffle pad (Basis of Design: Mason SW) in the method of attachment to structure to isolate the piping from structure.

G. All water heater and boiler combustion intake and flue gas vent piping shall be isolated from structure with neoprene pads. For all unistrut, hangers, clevis, etc. utilized for intake and vent piping hanging, provide a neoprene waffle pad (Basis of Design: Mason SW) in the method of attachment to structure to isolate the piping from structure. The full length of piping shall be isolated from structure.

END OF SECTION

SECTION 23 05 49

SEISMIC CONTROLS FOR MECHANICAL

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. The work in this section consists of providing engineering and materials necessary for seismic restraints for the mechanical systems and equipment provided in this project in Division 22 and 23.

B. Division 22 and 23 shall include seismic controls in their respective cost/cope of the project in accordance with the requirements of this section.

1.2 RELATED SECTIONS

A. Division 3 – Concrete

B. Division 22 – All sections where piping and equipment are furnished.

C. Division 23 – All sections where piping, equipment and ductwork are furnished

D. Section 23 05 48 – Vibration Isolation

1.3 RELATED WORK SPECIFIED IN OTHER SECTIONS

A. Fire Protection piping shall be installed with seismic restraints in accordance with the requirements of Section 21 00 00.

B. Seismic straps for water heaters furnished and installed in Section 22 30 00. Vibration isolation for seismic straps furnished and installed in Section 23 05 48.

1.4 SEISMIC CRITERIA

A. This section documents the Seismic criteria that apply to this project.
   1. Seismic Supports are required for Division 23.

B. Design and select restraint devices to meet seismic requirements as defined in the International Building Code, and applicable state and local codes and the following project specific requirements.
   1. Seismic Design Category B
   2. Risk Category: III
   3. For other Seismic Criteria, such as Site Specific Site Soil Class (Mapped Seismic Acceleration (SS), Mapped spectral response acceleration at 1 second period (S1), Seismic Use Group, see the structural drawings.

4. Mechanical System Importance Factor for Risk Category I, II and III facilities:
   a. Fuel Piping, Fuel Fired Equipment and related Venting: Ip=1.5
   b. Water Heaters: Ip=2.0
   c. All other Division 22/23 Pipe, Ductwork and Equipment, Ip=1.0
   d. Fuel in the context of this section involves flammable piping such as natural gas, propane, fuel oil etc.

C. In accordance with the International Building Code, the following Seismic Design Categories are exempt from Seismic Bracing of pipe, ductwork and equipment provided that the component is positively attached to the structure. **Water heaters are never exempt from Seismic Bracing. See Section 22 30 00 for seismic strap requirements.**
1. Seismic Design Category B (SDC-B) for equipment with Ip=1.0 and 1.5.

D. Except as specifically exempted in this section, engineered supports are required for all mechanical systems furnished in this project for all importance factors.

PART 2 - PRODUCTS

2.1 MANUFACTURERS (REFER TO SECTION 23 05 00)

A. Vibro-Acoustics

B. Amber Booth

C. Kinetics

D. Korfund

E. Mason Industries

F. Equipment with integral bases that meet the base requirements specified in this section shall not have additional bases provided.

2.2 VIBRATION ISOLATION

A. Refer to Section 23 05 48 for systems and equipment requiring vibration isolation. Seismic restraints shall factor vibration of spring isolation equipment.

2.3 FLEXIBLE PIPING CONNECTORS FOR NATURAL GAS

A. Flexible Pipe Connectors: Stainless Steel Hose
   1. Basis of Design: Mason CSAMN/CSAWM
   2. Braided flexible stainless steel hose.
   3. Hose to be rated at a minimum of 250 psi at 250 degrees F.
   4. Hose to be installed horizontally and parallel to equipment shaft.
   5. Hose to have a minimum length of 18 inches.

6. AGA/CSA approved for use on natural gas system. Meets ANSI/UL #536 2003 Standards for Flexible Metal Hose.
7. Hose to be selected for operating pressure with 4:1 minimum safety factor.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide in accordance with manufacturer's instructions.

B. Seismically restrain the water heater. Install fasteners, straps and brackets as required to secure the equipment. See Section 22 30 00.

3.2 CLEARANCES

A. Maintain a minimum of 3" in all directions between any sprinkler drop or sprig and the following items: permanently attached equipment including their structural supports and bracing; and other distribution systems including their structural sports and bracing.

B. Flexible piping connectors for natural gas
1. Provide at all equipment connections for gas fired equipment.

END OF SECTION

SECTION 23 05 53

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Ceiling Markers

B. Nameplates

C. Pipe Markers

D. Tags

E. Tag Chart

1.2 RELATED SECTIONS

A. Section 23 05 00 – Common Work Results for HVAC

B. Division 23 Piping, Valves, Equipment, and Control Sections

1.3 REFERENCES

A. ASME A13.1 - Scheme for the Identification of Piping Systems

1.4 SUBMITTALS FOR REVIEW (REFER TO SECTION 23 05 00)

A. Submit list of wording, symbols, letter size, and color coding for mechanical identification of all systems and equipment.

B. Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer’s name and model number.

C. Product Data: Provide manufacturers catalog literature for each product required.

1.5 OPERATION AND MAINTENANCE MATERIALS (REFER TO SECTION 23 05 00)

A. Include valve tag identification schedule.

PART 2 - PRODUCTS

2.1 NAMEPLATES

A. Description: Laminated three-layer plastic with engraved white letters on black background.

2.2 CEILING MARKERS

A. Manufacturers (refer to Section 23 05 00):
   1. Marking Services (MSI)
   2. Pipe Marker

B. Indoors: Durable, engraved plastic, black backgrounds and colored lettering. 1/16" plastic stock with adhesive backing.

C. Outdoors, laminated three-layer with engraved white letters on black ground with mounting holes.

D. Directional arrows to indicating which ceiling tile is to be removed for service.

E. Tag colors:
   1. HVAC Equipment: Orange
   2. Heating/cooling valves-Blue
   3. Plumbing Valves-Green
   4. Plumbing Cleanouts and equipment-White
   5. Controls-Yellow

2.3 PIPE MARKERS

A. Manufacturers: (Refer to Section 23 05 00):
   1. W.H. Brady
   2. Seton
   3. Marking Services, Inc.

B. Color and Lettering: Conform to ASME A13.1

C. Plastic Pipe Markers: Factory fabricated; flexible; semi-rigid plastic; preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.

D. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

2.4 TAGS

A. Description: Brass or Aluminum with stamped letters; tag size minimum 1½ inch diameter with smooth edges.

1. Provide ¼” letters for piping system abbreviation and ½” sequenced numbers. Provide 1/8” hole for fastener.

2.5 TAG CHART

A. Description: Typewritten letter size list in aluminum frame, plastic laminated. Chart shall include valve number, service and location.

PART 3 - EXECUTION

3.1 GENERAL

A. Install in accordance with manufacturer’s recommendations.

3.2 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Provide identifying devices after completion of coverings and painting.

3.3 NAMEPLATES/LABELS

A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive.

B. Install labels with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.

3.4 PIPE MARKERS

A. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

3.5 TAGS

A. Install tags using corrosion resistant chain. Number tags consecutively by location.

3.6 SCHEDULE

A. Identify all scheduled equipment (pumps, boilers, heat transfer equipment, unit heaters, etc.) and water treatment devices with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags. The plastic nameplates shall be large enough such that the structure hung equipment (ECU, GUH, and more) is identifiable while standing on grade.

B. Provide ceiling markers on t-bar and access panels to locate valves, fan coils, air terminal units and automatic (motorized) dampers above T-bar type panel ceilings and behind. Install adhesive ceiling markers to t-bar grid or access panel to indicate equipment and valve locations installed above ceilings. Provide direction arrows indicating ceiling tile requiring removal for service.

C. Identify control panels and major control components outside panels with plastic nameplates.

D. Identify valves in main and branch piping with tags. Exception: check valves, valves with factory-fabricated equipment units.

E. Identify air terminal boxes with numbered tags. Numbered tags shall be large enough such that the terminal boxes are identifiable while standing on grade.

F. Identify piping, concealed or exposed, with plastic pipe markers or plastic tape pipe markers. Identify service, flow direction, and pressure (when applicable). Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

G. Provide tagged valve schedule (individual to each building) to the owner.

END OF SECTION

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Testing, adjusting, and balancing of environmental systems including but not limited to air distribution, hydronics, domestic hot water recirculating systems and other miscellaneous systems, and the equipment and apparatus connected thereto.

1.2 DESCRIPTION

A. The Contractor shall secure the services of an independent Testing, Adjusting and Balancing (TAB) agency for the TAB of the mechanical systems as specified herein.

1.3 RELATED SECTIONS

A. Division 1 – Commissioning

B. Section 23 05 00 – Common Work Results for HVAC

C. Section 23 09 23 – Direct-Digital Control for HVAC

1.4 REFERENCES

A. AABC - National Standards for Total System Balance

B. ADC - Test Code for Grilles, Registers, and Diffusers

C. ASHRAE 111 - Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air-conditioning, and Refrigeration Systems

D. NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems

E. SMACNA - HVAC Systems Testing, Adjusting, and Balancing

1.5 SUBMITTALS FOR REVIEW (REFER TO SECTION 23 05 00)

A. Balancing Agency Information: Include name of balancing agency, documentation of either AABC or NEBB certifications and list of relevant project experience.

B. Submit signed guarantee of conformance of work with either AABC or NEBB standards as outlined in the Quality Assurance section of these specifications.

C. Submit proposed data sheets for each different type of equipment and system.

1.6 FIELD REPORTS (REFER TO SECTION 23 05 00)

A. Submit when deficiencies in systems prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance. Indicate deficiencies in the report.

B. Submit report prior to preparation of balancing report.

1.7 DATA SHEETS

A. Indicate data on AABC National Standards for Total System Balance forms or NEBB forms or an exact reproduction thereof.

B. Data sheets shall, at a minimum, indicate design and actual conditions for all information included in the equipment schedules on the drawings.

1.8 PRELIMINARY AND FINAL BALANCE REPORTS

A. Submit two (2) draft copies of preliminary balance report for review prior to final acceptance of Project for review.

B. Make required corrections to the TAB report and provide three (3) final copies of the balance report, one (1) for Architect/Engineer, and two (2) for inclusion in operating and maintenance manuals.

C. Provide Architect/Engineer’s final report in soft cover, letter size, securely bound manuals, complete with index page, indexing tabs, and cover identification. Reports for inclusion in the operating and maintenance manuals shall meet the same requirements, except binding shall be coordinated with the operation and maintenance manuals.

1.9 SUBMITTALS AT PROJECT CLOSEOUT (REFER TO SECTION 23 05 00)

A. Provide final balance reports for inclusion in the operation and maintenance manuals as described above.

1.10 REGULATORY REQUIREMENTS

A. Perform total system and equipment balance in accordance with AABC National Standards for Field Measurement and Instrumentation, Total System Balance or NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.

1.11 QUALIFICATIONS

A. Agency: Company specializing in the testing, adjusting, and balancing of systems specified in this section with a minimum of five (5) years, documented experience.

B. Perform work under the supervision of an AABC Certified Test and Balance Engineer or NEBB Certified Testing, Balancing and Adjusting Supervisor.

1.12 PRE-BALANCING CONFERENCE

A. Convene at project site one (1) week prior to commencing work of this section, under provisions of Section 23 05 00.

1.13 COORDINATION

A. See Section 23 05 00 for required interface between the sheetmetal, plumbing, and control contractor, and balance agency.

1.14 ACCEPTABLE TOLERANCES

A. All systems and equipment shall be adjusted to within plus or minus 10 % of design conditions.

1.15 APPROVED AGENCIES

A. Approved Agencies (Refer to Section 23 05 00)
   1. Testcomm
   2. NWESI
   3. BSTCX
   4. Blue Sky
   5. Or Approved Equal

B. Agencies seeking approval for the Testing and Balancing work shall submit for approval during the bid period as specified in Section 23 05 00. The request for substitution shall contain the following information. Requests lacking this information will not be approved.
   1. Certification of membership with AABC or NEBB
   2. Representative list of projects with at least five projects of similar size and scope to this project.
   3. Design Engineer and Owner references - a minimum of two of each

PART 2 - (NOT USED)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that systems are complete and operable before commencing work. Ensure that the items on the pre-balance checklist are completed.

B. Submit field reports as required to report defects and deficiencies noted during performance of services which prevent system balance.

3.2 PREPARATION

A. Provide instruments required for testing, adjusting, and balancing operations.

3.3 PROCEDURES

A. All procedures shall be in accordance with and meet all the requirements of either AABC or NEBB procedural standards. The requirements listed in this section are intended to be supplementary to the requirements of these standards.

B. Supplemental Requirements
   1. Ensure recorded data represents actual measured or observed conditions.
   2. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
   3. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
   4. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
   5. At project closeout, Balancing Agency shall be represented at final observation meeting by qualified testing personnel with balancing equipment and two (2) copies of air balancing test report.
      a. Owner’s Representative may choose and direct spot balancing of one zone. Differences of 10 % or more between the spot balance and test report will be justification for requiring repeat of testing and balancing for entire building.
      b. Re-balancing shall be done in presence of Owner’s Representative or Engineer and subject to their approval.
      c. Spot balance and re-balance shall be performed at no additional cost to Owner. The Contractor shall compensate the Owner’s Representative for additional time and expense incurred.

3.4 AIR SYSTEM PROCEDURE

A. Adjust air handling and distribution systems to provide design supply, return, outside air, and exhaust air quantities at site altitude.

B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct. Traverse shall be used for fan total airflow measurement and calibration of airflow measuring stations and terminal units. Branch traverses shall be totalized where a single traverse is not feasible. Any other method of total airflow measurement shall be approved by engineer.

C. Measure air quantities at air inlets and outlets.

D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.

E. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers.

F. Vary total system air quantities by adjustment of fan speeds. Calculate drive changes and coordinate with the Sheet Metal contractor for changeout. Vary branch air quantities by damper regulation.

G. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters. In cooperation of Section 23 09 23, set adjustments of automatically operated dampers as specified, indicated or noted.

H. Adjust outside air dampers, outside air, return air, and exhaust dampers for design conditions.

I. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

J. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.

K. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches w.g. positive static pressure near the building entries.

L. For variable air volume system terminal units set volume controller to minimum and maximum air flow settings indicated. Minimum and maximum stops shall be set and marked. Measurements made in the maximum air configuration shall be obtained with a sufficient number of boxes in the maximum mode to achieve scheduled maximum total in delivery for the air handler. Measurements made in the minimum air configuration shall be made with all boxes in the minimum mode.

M. Where air handling equipment supplied to the job provides up to 10% more or less air than design requirements, rooms supplied by that unit will require more precise balance so that the outlets/inlets are within the previously indicated +/-10% of design.

N. Maintain differentials between supply and return or exhaust quantities so that space pressurization is maintained.

3.5 HYDRONIC SYSTEM WATER SYSTEM PROCEDURE

A. Preparation of System - Phase I
   1. Open valves fully, including coil stop valves and return line balancing cocks. Close bypass valves.
   2. Examine water in system to determine if it has been treated and is clean.
   3. Check pump rotation.
   4. Check expansion tanks to make sure they are not water logged or air bound and system is full of water.
   5. Make certain air is removed from circulating system.
   6. Set controls to insure full flow thru coils and equipment. If both heating and cooling is involved, each system shall be balanced in the full flow conditions.
   7. Check operating temperature of boilers and other equipment. For systems with glycol, set system fluid temperature so that the average fluid temperature matches design conditions. This may necessitate initial balance at time of substantial completion and final balance in peak heating and cooling season.
      a. For example, a cooling system with a chiller selected to operate between 45 and 60 degrees shall be balanced at these conditions or an average temperature between supply and return of 52.5 degrees.
      b. For multimode systems such as heat pumps balance at the average design temperature of the cooling mode.
      c. Hydronic heat recovery pumps should be balanced in the heating season with the average fluid temperature determined from the winter recovery coil selections.

B. Performance of Testing and Balancing - Phase II
   1. Set circulating pumps to proper g.p.m. delivery.
   2. Adjust flow of water through boilers, heat exchangers and other equipment.
   3. Check leaving water temperatures, return water temperatures, and pressure drop through equipment. Reset to correct design temperatures.
   4. Upon completion of flow readings and coil adjustments, mark settings and record data.

C. Performance of Testing and Balancing - Phase III
   1. After making adjustments to equipment, recheck settings at pumps and equipment. Re-adjust if required.
   2. Check water temperature at inlet side of cooling and heating coils. Note rise or drop of temperatures from source.
   3. Set controls to minimum position to insure flow through bypass pipes to achieve identical flow rates as that through the coils or equipment.
   4. Follow same procedure for all 3-way and bypass valves.

D. Pumps which can deliver more than 10% over design flow at the actual system pressure experienced under installed conditions shall have impellers trimmed so that flow is 110% of design flow at full hertz. Test agency shall make recommendations to plumbing contractor regarding pump impeller changes.

E. Check and record data at each cooling and/or heating element and circulating pump. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts. Alternatively, when parallel pumps have been provided, multiple pumps can be operated simultaneously to provide 100% design system flow provided that both pumps

can be operated without damage to the system. Where pressure independent balancing valves are used, record valve information (manufacturer, size, and flow), record pressure at device, and verify it is within the range of the valve and that minimum pressures are satisfied. Fluid differential temperature across the coil shall be recorded on the balance form.

3.6 DOMESTIC HOT WATER SYSTEM

A. Check, adjust and record flow rate at recirc pumps and branch circuit setters to the flow rates on the drawings.

3.7 SCHEDULES

A. Equipment Requiring Testing, Adjusting, and Balancing
   1. Domestic Water Recirculation Pumps and system
   2. HVAC Pumps
   3. Heating and Cooling Coils
   4. Terminal Heat Transfer Units
   5. Air Handling Units
   6. Make-Up Air Units
   7. Exhaust Fans
   8. Vehicle Exhaust Collection Units
   9. Air Terminal Units (VAV Boxes)
   10. Air Inlets and Outlets
   11. Split Systems
   12. Boilers
   13. Variable Frequency Drives

B. Report Forms
   1. Title Page:
      a. Name of Testing, Adjusting, and Balancing Agency
      b. Address of Testing, Adjusting, and Balancing Agency
      c. Telephone number of Testing, Adjusting, and Balancing Agency
      d. Project name
      e. Project location
      f. Project Architect
      g. Project Engineer
      h. Project Contractor
      i. Project altitude
      j. Report date
   2. Summary Comments:
      a. Design versus final performance
      b. Notable characteristics of system
      c. Description of systems operation sequence
      d. Summary of outdoor and exhaust flows to indicate amount of building pressurization.
      e. Nomenclature used throughout report
      f. Test conditions
   3. Instrument List:
      a. Instrument

b. Manufacturer
c. Model number
d. Serial number
e. Range
f. Calibration date

4. Electric Motors:
   a. Manufacturer
   b. Model/Frame
   c. HP/BHP
   d. Phase, voltage, amperage; nameplate, actual, no load
   e. RPM
   f. Service factor
   g. Starter size, rating, heater elements
   h. Sheave Make/Size/Bore
5. Pump Data:
   a. Identification/number
   b. Manufacturer
   c. Size/model
   d. Impeller
   e. Service
   f. Design flow rate, pressure drop, BHP
   g. Actual flow rate, pressure drop, BHP
   h. Discharge pressure
   i. Suction pressure
   j. Total operating head pressure
   k. Shut off, discharge and suction pressures
   l. Shut off, total head pressure
   m. System supply water temperature (design)
   n. System Return water temperature (design)
   o. System supply water temperature (as balanced)
   p. System Return water temperature (as balanced)
6. Boiler Data:
   a. Boiler manufacturer
   b. Model number
   c. Serial number
   d. Design flow rate/actual flow rate
   e. Water pressure drop
7. Cooling Coil Data:
   a. Identification/number
   b. Location
   c. Service
   d. Manufacturer
   e. Air flow, design and actual
   f. Water flow, design and actual
   g. Water pressure drop, design and actual (where applicable)
8. Heating Coil Data:
   a. Identification/number
   b. Location
   c. Service
   d. Manufacturer
   e. Air flow, design and actual

f. Water flow, design and actual
g. Water pressure drop, design and actual

9. Air Moving Equipment
   a. Location
   b. Manufacturer
   c. Model number
   d. Serial number
   e. Arrangement/Class/Discharge
   f. Supply air flow, specified and actual
   g. Return air flow, specified and actual
   h. Outside air flow, specified and actual
   i. Total static pressure (total external), specified and actual
   j. Inlet pressure
   k. Discharge pressure
   l. Sheave Make/Size/Bore
   m. Number of Belts/Make/Size
   n. Fan RPM
   o. On systems with supply and return or exhaust fans record offset volumes used for system pressurization. On variable volume systems, forward offset volumes to the EMCS contractor for input into their programming for return fan tracking.
   p. On AH and HR systems record heat exchanger and filter air pressure drops.
10. Exhaust Fan and Vehicle Collection Unit Data:
   a. Location
   b. Manufacturer
   c. Model number
   d. Serial number
   e. Air flow, specified and actual
   f. Total static pressure (total external), specified and actual
   g. Inlet pressure
   h. Discharge pressure
   i. Sheave Make/Size/Bore
   j. Number of Belts/Make/Size
   k. Fan/RPM
   l. For exhaust fans that exhaust to the outdoors and switch on/off during occupied mode, forward final balanced air volumes to the EMCS contractor for input into their programming for return fan tracking.
11. Duct Traverse:
   a. System zone/branch
   b. Duct size
   c. Area
   d. Design velocity
   e. Design air flow
   f. Test velocity
   g. Test air flow
12. Air Flow Measuring Station:
   a. Identification/number
   b. Location
   c. Size
   d. Manufacturer
   e. Model number
   f. Serial number

g. Design flow rate
h. Design pressure drop
i. Actual/final pressure drop
j. Actual/final flow rate
    1) Station calibrated setting

13. Terminal Unit Data:
    a. Manufacturer
    b. Type: constant, variable, single, dual duct, fan powered
    c. Identification/number
    d. Location
    e. Model number
    f. Size
    g. Minimum static pressure
    h. Minimum design air flow
        1) Minimum unoccupied heating
        2) Minimum occupied heating
        3) Maximum occupied heating
    i. Maximum design air flow
    j. Maximum actual air flow
    k. Minimum actual air flow
        1) Minimum unoccupied heating
        2) Minimum occupied heating
        3) Maximum occupied heating
    l. Inlet static pressure
14. Air Distribution Test Sheet:
    a. Room number/location
    b. Air inlet/outlet type
    c. Air inlet/outlet size
    d. Area factor
    e. Design velocity
    f. Design air flow
    g. Test (final) velocity
    h. Test (final) air flow
    i. Percent of design air flow
    j. For rooms with exhaust, identify:
        1) Design offset cfm
        2) Actual offset cfm
15. Domestic Hot Water Recirculating Systems
    a. See pump data previously specified.
    b. Circuit setter location, type, size, mfr
    c. Circuit setter location
    d. Design flow rate
    e. Actual flow rate
16. Variable Frequency Drives
    a. Mfr, size, amp rating, heater/fuse settings
    b. Control pressure
    c. Critical zones (top 3 driving the control pressure setpoint)
    d. VFD speed (hz) and amps at maximum design conditions
    e. VFD speed (hz) and amps at minimum design conditions

END OF SECTION

SECTION 23 07 00

HVAC INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Pipe and Equipment Insulation

B. Duct Insulation

C. Inserts and Shields – Installation

D. Jackets and Fitting Covers

1.2 RELATED SECTIONS

A. Section 23 05 00 – Common Work Results for HVAC

B. Section 23 05 17 – Sleeves and Sleeve Seals for HVAC

C. Section 23 05 23 – General Duty Valves for HVAC Piping

D. Section 23 05 29 – Hangers and Supports for HVAC Piping and Fittings

E. Section 23 05 53 – Identification for HVAC Piping and Equipment

F. Section 23 21 13 – Hydronic Piping

G. Section 23 23 00 – Refrigerant Piping

H. Section 23 31 00 – HVAC Ducts and Casings

1.3 REFERENCES

A. General
1. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials
2. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials
3. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials
4. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials
5. ASTM C518 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
6. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation

7. ASTM C665-Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
8. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials
9. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials
10. ASTM E162 - Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source
11. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi
12. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials
13. SMACNA - HVAC Duct Construction Standards - Metal and Flexible
14. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials

B. Cellular Foam
1. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
2. ASTM D1056 - Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber

C. Glass Fiber
1. ASTM C547 - Standard Specification for Mineral Fiber Preformed Pipe Insulation

D. Jackets and Fitting Covers
1. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
2. ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation
3. ASTM D1784 - Standard Specification for Rigid PolyVinyl Chloride (PVC) Compounds Chlorinated PolyVinyl Chloride (CPVC) Compounds

E. Fire Rated Duct Insulation
1. ICC-ES AC101-Field Applied Grease Duct Enclosure Assemblies
2. ASTM E2336-Grease Duct Test Standard
3. ASTM E119 Standard Test Methods for Fire Tests of Building Construction and Materials
4. ASTM E814-Standard Test method for Fire Tests of Penetration Fire Stop Systems
5. ASTM E84-Standard Test method for Surface Burning Characteristics of Building Materials
6. ASTM E136-Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750 degrees C.
7. ASTM E518-Standard Test Method for Thermal Resistance
8. ISO 6944-85-Fire Resistance Tests-Ventilation Ducts

F. Glass fiber, Flexible Blanket (Duct Wrap)
1. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications

G. Glass Fiber, Flexible (Duct Liner)
1. ASTM C1071 - Standard Specification for Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material)

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

B. Applicator Qualifications: Company specializing in performing the work of this section with minimum three (3) years documented experience and who is authorized by the manufacturer.

1.5 SUBMITTALS FOR REVIEW (REFER TO SECTION 23 05 00)

A. General
1. For each insulation type, provide material characteristics, minimum and maximum service temperatures, moisture absorption characteristics, thermal and vapor transmission characteristics.
2. Provide a schedule indicating insulation type and thickness for each specific pipe, equipment and duct system and installation type.

B. Fire Rated Duct Insulation
1. Include Material Safety Data Sheet (MSDS) for specified products and systems.
2. Include product data for insulation and approved fire stop indicating materials used and code compliance.
3. Submit manufacturer’s installation instructions.

1.6 REGULATORY REQUIREMENTS

A. General
1. Conform to flame spread/smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255, and UL 723. This shall apply to insulation as well as to all accessories including but not limited to adhesives, mastics, jackets, cements, tapes, cloth for fittings, etc.
2. Material packaging shall be clearly UL labeled for the intended purpose.

B. Fire Rated Duct Insulation
1. System shall be a complete UL listed and tested assembly.

1.7 DELIVERY, STORAGE, AND HANDLING

A. In accordance with Section 23 05 00.

B. Accept materials on site in original factory packaging, labeled with manufacturer’s identification, including product density and thickness.

C. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

B. Maintain temperature during and after installation for minimum period of twenty-four (24) hours.

PART 2 - PRODUCTS

2.1 CELLULAR FOAM (PIPING)

A. Manufacturers (Refer to Section 23 05 00):
1. Armstrong, Armaflex-AP
2. Halstead

B. Insulation: ASTM C534; flexible; cellular elastomeric; molded or sheet; *k* factor: ASTM C177, 0.27 Btu·in/(h·ft²·°F) at 75 °F; -70 °F minimum service temperature; 220 °F maximum service temperature; maximum moisture absorption: ASTM D1056, 5.0 percent (pipe) by weight; 6.0 percent (sheet) by volume; moisture vapor transmission: ASTM E96, 0.10 perm-inches.

C. Connection: Waterproof vapor barrier contact adhesive compatible with the insulation. Armstrong 520 adhesive or approved equal.

2.2 GLASS FIBER (PIPING)

A. Manufacturers (Refer to Section 23 05 00):
1. Johns Manville, Micro-Lok, AP-T Plus
2. Knauf
3. Owens Corning

B. Insulation: ASTM C547; rigid molded; noncombustible; *k* factor: ASTM C177, 0.24 Btu·in/(h·ft²·°F) at 75 °F; 850 °F maximum service temperature; 0.2 percent maximum moisture absorption by volume.

C. Vapor Barrier Jacket: White kraft paper with glass fiber yarn; bonded to aluminized film with pressure sensitive tape lap sealing system; moisture vapor transmission: ASTM E96; 0.02 perm-inches.

D. Provide with GreenGuard Certification for Children and Schools.

2.3 JACKETS AND FITTING COVERS (PIPING)

A. PVC Plastic Jacket and Fitting Covers (Interior Applications):
1. Manufacturers (Refer to Section 23 05 00):
a. Zeston 2000
b. Speedline Corporation

2. Jackets and fitting covers: ASTM D1784; one-piece molded type fitting covers and sheet material; off-white color; minimum service temperature: 0 °F; maximum service temperature: 450 °F; thickness: 20 mil.
3. Jackets and fitting covers (vapor barrier jackets): ASTM D1784; one-piece molded type fitting covers and sheet material; off-white color; minimum service temperature: 0 °F; maximum service temperature: 450 °F; moisture vapor transmission - ASTM E96 - 0.002 perm-inches; thickness: 20 mil.
4. Connections: Pressure sensitive color matching vinyl tape

B. Piping and Insulation Jacket (Exterior Applications): ASTM B209
1. Manufacturers (Refer to Section 23 05 00):
   a. JAirex
2. Or approved equalBasis of Design: E-FlexGuard
3. Jacket: The PVC plastic pipe insulation cover shall feature an integrated, outdoor-rated durability, industrial-grade, full-enclosure fastening system that is double secured by molecular bonding, allowing custom, cut-to-length installations. The cut-to-length installations shall comprise of a non-un-raveling PVC cover material that does not compromise long-term-effectiveness or require specialized tools and cutting equipment. The engineered fastening system is to allow the cover to be removable and reusable for maintenance without the use of adhesives as an attachment in any way shape or form, including either in the protector's construction, installation, or attachment to pipe insulation, as this will negatively affect insulation permeance performance and promote insulation material degradation which causes added energy usage by equipment. WRAPPING TAPE OR ADHESIVE TAPE SHALL NOT BE PERMITTED AS PER ENERGY CODES.
4. Protector shall be tested and meet the following testing:
   a. ASTM E 96 (Vapor Transmission of Materials)
   b. ASTM G 153 (Carbon Arc Light Exposure – Accelerated Weathering)
   c. ASTM D 412 (Tensile Strength after UV Exposure and Water Immersion)
   d. ASTM 570 (Water Absorption of Plastics)
   e. ASTM E 84/UL 723 (Surface Burning Characteristics of Building Materials)
   f. ASTM G 21 (Fungal Growth). UV/Protector Pipe Insulation Material shall Meet Class II vapor retarder per ASTM E 96 (vapor/moisture permeability test) "1 perm or less".
5. The use of u/v paint or non-permeable materials or adhesives are not permitted for this application.
6. Color shall be black.
7. Sizing of insulation protector shall allow for mini-split line set piping to be fully encapsulated by insulation protector. Coordinate with final mini split submittals for line set sizing.
8. Metal Jacket Bands: 3/8 inch wide; 0.015-inch-thick aluminum.

2.4 INSULATION INSERTS FOR PIPE SHIELDS AND SADDLES

A. Insulation Inserts:
1. At pipe shields:
   a. Extra heavy density insulation which will not crush from weight of pipe.
   b. Thickness same as scheduled for pipe insulation
   c. Cover no less than 40% of the circumference of the insulation for pipe supported from hangers. Cover 100% of the circumference of the pipe for pipe supported on trapeze.

d. Pittsburg-Corning Foamglas, Calcium Silicate or approved equal.
e. Length to match shield length. Coordinate with Section 23 05 29.

2. At Saddles
   a. Pittsburg-Corning Foamglas, Calcium Silcate or approved equal.
   b. Pre-cut pipe insulation to fit within saddle to maintain insulation integrity of pipe at the saddle location.
   c. Lengths to match saddle length.

B. Inserts: Heavy density insulation which will not crush from weight of pipe. Locate between shield and pipe. Inserts are furnished in this Section 23 07 00 and installed in Section 23 05 29.

C. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and insulation. Shields are furnished and installed under Section 23 05 29.

2.5 GLASS FIBER (EQUIPMENT)

A. Manufacturers (Refer to Section 23 05 00):
   1. Johns Manville - Pipe and Tank Insulation
   2. Owens Corning

B. Insulation: Semi-rigid, noncombustible; *k* factor: ASTM C335 0.27 Btu·in/ (h·ft²·°F) at 75 °F; maximum service temperature: 650 °F; density: 3.0 pounds/foot³.

C. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film with pressure sensitive tape lap sealing system; moisture vapor transmission: ASTM E96; 0.02 perm-inches.

2.6 LACE-ON BLANKETS

A. Manufacturers (Refer to Section 23 05 00):
   1. Insulation
      a. Kaowool Cerablanket
   2. Fabric
      a. JP Stevens Glass-Tex Fabric Style 9987
      b. Alpha Maritex Style 3200-SA

B. Materials: 0.008-inch-thick type 304 stainless steel knitted wire mesh inner liner 8 pounds/foot³ density insulation, ½ inch thick; oil and water resistant exterior protective fabric.

C. Construction: Blankets shall be sewn together. Lacing anchors shall be 2½ inch stainless steel secured with 12-gauge stainless steel washers. Blankets shall have stainless steel wire installed for draw cords.

2.7 REUSABLE VALVE COVERS (HYDRONIC PIPING) (INDOOR ONLY)

A. Manufacturers (Refer to Section 23 05 00):
   1. No Sweat Valve Wraps

B. Product shall be engineered for a wide variety of valves including strainers, automatic balancing devices, circuit setters, ball valves, butterfly valves, control valves and check valves. Product consists of outer jacket, closure assembly and fiberglass insulation.

C. Outer jacket shall be made of material equal to DuPont Tychem® QC, overlapping and completely covering the insulation with seams joined by tabs made from hook and loop fasteners (Velcro). Butt ends shall have sewn- in-place elastic. Weight of 2.5 oz per square yard, 10 mils thickness, 0.01 Perms water vapor transmission, 65 psi Mullen burst strength, white/glass finish, UV resistant

D. Outer jacket shall overlap adjoining sections of pipe insulation.

E. Installation shall not require the use of any special hand tools.

F. Suitable for continuous operation at 200 degrees Fahrenheit with insulation insert blankets

G. Fire and smoke performance: Flame spread less than 25, smoke developed less than 50 per ASTM E84.

H. Insulation Inserts: Fiberglass k-factor 0.26 per inch (ASTM C77). Provide 1 or more layers to meet or exceed minimum insulation thickness requirements as indicated in pipe schedules in Part 4 of this specification.

2.8 FIRE RATED DUCT INSULATION

A. Manufacturers (Refer to Section 23 05 00):
1. Pyroscat FP Ductwrap
2. Fyrewrap
3. 3-M fire Barrier Ductwrap

B. Ventilation Duct Insulation
1. Materials and equipment provide a 2-hour fire-resistive rated duct enclosure for air distribution systems.
2. Testing to be conducted by a nationally recognized testing laboratory.
3. Performance Requirements:
   a. Single layer system for two hour fire rating.
   b. 2-hour fire resistive enclosure assembly tested per ISO 6944 – 1985 Edition
   c. Firestop system, tested per ASTM E-814, 2-hour F and T Ratings
4. A flexible, fully encapsulated duct wrap material to provide 2-hour fire resistive enclosure assembly per ISO 6944 – 1985
5. A lightweight, 1.5” thick, 6pcf, flexible, inorganic, non-asbestos, noncombustible, biosoluble core insulation blanket.
6. Blanket insulation must maintain a 2012ºF (1100ºC) operating temperature
7. Blanket fiber materials must be tested per EU regulatory requirements
8. Directive 97/69/EC for bio-solubility, and verified by an independent laboratory.
9. Provide firestop sealants, tape, insulation pins, clips, banding and other components per manufacturer’s instructions to ensure the installation complies with the complete tested system and corresponding Design Listing(s).

2.9 GLASS FIBER, FLEXIBLE BLANKET (DUCT WRAP)

A. Manufacturers (Refer to Section 23 05 00):
1. Johns Manville, R-Series Microlite FSK
2. Certainteed; Standard Ductwrap
3. Knauf; Ductwrap
4. Owens Corning; All Service Ductwrap

B. Insulation: ASTM C553; flexible, noncombustible blanket; *k* factor: ASTM C518, 0.27Btu·in/(h·ft²·°F) at 75 °F; maximum service temperature: 250 °F; maximum moisture absorption: 0.20 % by volume; density: 0.75 pounds/foot³; resistance to microbial growth: ASTM C665; shall not support mold, bacteria, or fungus growth.

C. Thermal Properties

Labeled Thickness (inches)	Installed R-Value (hr*ft2*deg F)/btu	Out of package R-Value (hr*ft2*deg F)/btu
1	3	3.8
1 ½	4.2	5.2
2	5.6	6.9
2 1/5	6	7.5
3	8.3	10.3
4 2/5	12	12
5 ¾	16	20
7	19	23

D. Vapor Barrier Jacket: Foil Scrim Kraft (FSK); foil thickness: 0.00035 inches; moisture vapor transmission: ASTM E96; 0.02 perm; Class I vinyl; vinyl thickness: 0.0032 inches; moisture vapor transmission: ASTM E96; 1.3 perm; vapor barrier tape: same material as vapor barrier jacket as recommended by the insulation manufacturer.

2.10 GLASS FIBER, FLEXIBLE (DUCT LINER)

A. Manufacturers (Refer to Section 23 05 00):
1. Knauf - Duct Liner E-M
2. Certainteed - Toughgard
3. Johns Manville - Linacoustic RC (Permacote)

B. Insulation: ASTM C1071; flexible, noncombustible bonded glass fiber blanket with a black matt faced surface for damage resistance; *k* factor: ASTM C1071, maximum 0.24 Btu·in/(h·ft²·°F) at 75 °F; maximum service temperature: 250 °F; maximum rated air velocity on coated air side: 6,000 fpm; surface coating with EPA registered anti-microbial agent that will not support growth of fungus or bacteria; anti-microbial agent shall be tested in accordance with: fungi test ASTM C665, fungi test ASTM G21, bacterial test ASTM G22. Insulation coating shall be formaldehyde free.

C. Unless indicated otherwise on the drawings, liner shall be 1” with a minimum R-value of 4.2 (hr*ft2*deg)/btu.

D. Adhesive:
1. Manufacturers (Refer to Section 23 05 00):

a. DuroDyne; WBG
b. Miracle; PF96
c. Scotchgrip Insulation Adhesive; 4230

2. Waterproof, ASTM E162 fire-retardant type

E. Mechanical Fasteners:
1. Conform to SMACNA Mechanical Fastener Standard MF-1-1975
a. Manufacturers (Refer to Section 23 05 00):
b. DuroDyne
c. Omark dished head “Insul-Pins”
d. Grip nails may be used if nail is installed by “Grip Nail Air Hammer” or by “Automatic Fastener Equipment” in accordance with Manufacturer’s recommendations.

2.11 EXTERIOR DUCTWORK INSULATION

A. Glass Fiber, Rigid (Ductwork)
1. Manufacturers (Refer to Section 23 05 00):
a. Johns Manville, Spin-Glas type 814
2. Insulation: ASTM C612; rigid, noncombustible blanket; *k* factor: ASTM C518, 0.23 Btu·in/ (h·ft²·°F) at 75 °F; maximum service temperature: 450 °F; maximum moisture absorption: 1 % by volume; density: 3.0 pounds/foot³.
3. Facing: provide with FSK aluminum foil reinforced with fiberglass yarn and laminated with fire-resistant adhesive to Kraft paper.
4. Aluminum jacket for exterior insulated ductwork
a. ASTM C1729.
b. Thickness: minimum 0.016-inch-thick sheet.
c. Longitudinal slip joints and minimum 2-inch laps.
d. Metal Jacket Bands: minimum 3/8 inch wide; minimum 0.015-inch-thick aluminum.

PART 3 - EXECUTION

3.1 EXAMINATION – GENERAL

A. Verify that piping and ductwork has been tested and approved before applying insulation materials.

B. Verify that surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION – GENERAL – (PIPING)

A. Continue insulation with vapor barrier through penetrations.

B. On exposed piping in finished areas, locate insulation and cover seams in least visible locations.

C. Insulate pipes in accordance with the insulation schedule.

D. On insulated piping with vapor barrier, insulate fittings, valves, unions, flanges, strainers, flexible connections and expansion joints.

E. On insulated piping without vapor barrier for pipes conveying fluids 180° F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation at such locations.

F. Install materials in accordance with the manufacturer's instructions.

G. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions.

H. Insulation on all cold water systems shall be applied with a continuous unbroken vapor seal. Do not allow hangers, supports, anchors etc., to come in direct contract with the pipe.

I. Insulate entire system including fittings, unions and flexible connections, flanges and expansion joints. For insulation of valves and other pieces of equipment, see Section 23 07 00. At fire separations, Refer to Section 23 05 17 and Division 7 - Fire Stopping.

3.3 CELLULAR FOAM INSULATION (PIPING)

A. Cover pipe and fittings with insulation in thickness scheduled.

B. Insulation shall fit in snug contact with pipe and be installed in accordance with the manufacturer's recommendations.

C. Slip insulation on tubing before tubing sections and fittings are assembled keeping slitting of insulation to a minimum.

D. Seal joints in insulation with adhesive.

E. Insulate fittings with pre-molded covers or sheet insulation.

F. Stagger joints on layered insulation.

G. Insulation exposed outside shall have "slit" joint seams places on the bottom side of the pipe.

H. Paint exterior exposed insulation with two coats of gray finish recommended by the Insulation manufacturer to protect from weather and sunlight.

3.4 GLASS FIBER INSULATION (PIPING)

A. Cover pipe with glass fiber insulation in thickness scheduled.

B. When vapor barrier is required, adhere factory applied vapor barrier jacket lap smoothly and securely at longitudinal laps with pressure sensitive strip. Adhere self-sealing butt joint strips over end joints. No staples will be allowed.

C. Insulate fittings and joints with molded insulation of like material and thickness of adjacent pipe with ends of insulation tucked snugly into throat of fitting and edges adjacent to pipe insulation tufted and tucked in.

D. Cover insulation with one piece PVC fitting covers.

3.5 JACKETS AND FITTING COVERS (PIPING)

A. Apply insulation prior to installation of jackets and fitting covers.

B. Insulated pipe located outdoors and insulated pipe penetrations through exterior walls: finish with piping and insulation jacket.

C. Pipe exposed in finished spaces less than 10 feet above finished floor, and where indicated on drawings: finish with PVC jacket and fitting covers.

D. Secure PVC jackets and fitting covers with stainless steel tacks and wrap seams and tacks with vinyl tape.

E. Install aluminum jackets located outdoors with seams located on bottom side of horizontal piping. Apply sealing compound and closures to make weathertight.

3.6 INSERTS AND SHIELDS

A. Insulation inserts are furnished in this section and provided to Section 23 05 29 for installation.

B. Install finished piping insulation tight to inserts with tightly fitting butt joints. Maintain continuous vapor barrier and jacketing at pipe joints

3.7 INSTALLATION – GENERAL – (EQUIPMENT)

A. General
1. Provide materials in accordance with the manufacturer’s recommendations.
2. Factory Insulated Equipment: Do not insulate.
3. Finish insulation at supports, protrusions, and interruptions.
4. Nameplates and ASME Stamps: Bevel and seal insulation around with a mastic. Do not insulate over.
5. Exposed Equipment in Finished Areas: Locate insulation and cover seams in least visible locations.
6. Cover field insulated tanks with aluminum jackets.

B. Hydronic Valve Covers: For indoor hydronic valves requiring access for maintenance, repair or cleaning: Insulate with reusable valve covers. Install insulation in single or multiple layers to match scheduled insulation thickness.

3.8 GLASS FIBER (EQUIPMENT)

A. For equipment not requiring access for maintenance, repair or cleaning.

B. Cover equipment with glass fiber insulation in thickness scheduled.

C. Provide vapor barrier jackets. Adhere factory applied vapor barrier jacket lap smoothly and securely at longitudinal laps with pressure sensitive strip. Adhere self-sealing butt joint strips over end joints. No staples will be allowed.

3.9 LACE-ON BLANKETS

A. Provide for equipment requiring access for maintenance, repair, or cleaning: insulate with lace on blanket.

B. Install in single or multiple layers to match scheduled insulation thickness for associated piping system.

C. Blankets shall be removable and reusable.

3.10 VALVE COVERS

A. Install in accordance with manufacturer requirements

B. Schedule:
1. Outdoor valves: Provide lace-on blankets.
2. Indoor hydronic valves: Provide lace-on blankets or reusable valve covers.

C. Indoor steam valves: Provide lace-on blankets.

3.11 FIRE RATED DUCT INSULATION

A. Provide system where indicated on the drawings for exhaust ducts. Install in accordance with UL listing and manufacturer’s instructions.

B. The intent of the fire rated duct insulation around the permanent portable vehicle exhaust unit ductwork is to prevent high temperature ductwork from physical contact to prevent scalding. It is not intended to create a 2 hour fire rated enclosure around the ductwork.

3.12 INSTALLATION (DUCTWORK)

A. General
1. Install in accordance with manufacturer’s recommendations and SMACNA HVAC Duct Construction Standards, Metal and Flexible, latest edition.

B. Glass Fiber, Flexible Blanket (Duct Wrap)
1. Provide glass fiber, flexible insulation (blanket type) as scheduled.

2. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
3. Insulate entire system including fittings, joints, flanges, and expansion joints.
4. Wrap insulation tightly (avoid over compressing) on ductwork with all points butted. Adhere insulation to the ductwork with 4-inch strip of bonding adhesive on 8 inch centers.
5. Overlap all joints and completely seal with vapor barrier tape.
6. Install without sag on underside of ductwork. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift ductwork off trapeze hangers and insert spacers.
7. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
8. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping. Seal and bevel the ends of the insulation.

C. Glass Fiber, Flexible (Duct Liner)
1. Provide glass fiber duct liner, flexible, as scheduled.
2. Install matt faced surface facing the air stream side. Adhere insulation with fire resistive adhesive for 100 % coverage.
3. Accurately cut liner, point all joints, and thoroughly coat connecting ends with fire resistive adhesive. Butt joints tightly. Top and bottom sections of insulation shall overlap sides. All exposed edges shall be sealed (buttered).
4. If insulation is installed without horizontal, longitudinal, and end joints sealed and buttered together, installation will be rejected and work removed and replaced with work that conforms to this specification.
5. When two or more layers of liner board are required, joints shall be staggered.
6. Secure insulation with mechanical liner fasteners. Refer to SMACNA Standards for spacing.
7. Seal liner surface penetrations with adhesive.
8. Duct dimensions indicated on the plans are gross outside dimensions. Thickness of duct liner has been considered in sizing the ductwork. Do not increase duct size to allow for insulation thickness.

D. Glass Fiber, Rigid
1. Provide glass fiber, rigid insulation in the thickness scheduled.
2. Insulate entire system including fittings, joints, flanges, flexible connection, and expansion joints.
3. Install on ductwork with all points butted. Adhere insulation to the ductwork according to the manufacturer’s recommendations.
4. Overlap all joints and completely seal with vapor barrier tape.
5. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
6. Thoroughly coat with asphalt-based emulsion product for a water-proof finish.

E. Ducts Exterior to Building:
1. Install insulation according to insulation requirements in preceding sections with type scheduled at end of this section.
2. Provide external insulation with vapor retarder jacket. Insulate pressure relief doors. Insulation shall allow doors to blowout and reset without damaging insulation. Seal all seams water tight.
3. Cover with outdoor jacket finished with caulked aluminum jacket with seams located on bottom side of horizontal duct section. Finish with aluminum duct jacket.
4. Calk seams at flanges and joint. Located major longitudinal seams on bottom side of horizontal duct sections.

5. Longitudinal seams may be standing seams similar to ductmate type flanges-fully sealed in lieu of band straps.
6. Provide cross breaking and cricketed rigid insulation on top of duct to divert standing water from the top jacketing.

PART 4 - SCHEDULES

4.1 SCHEDULES

A. Insulate heating and cooling equipment including valves, tanks, traps, convertors, radiant ceiling panels, air removal devices, flash tanks, condensate receivers, etc.

B. Insulate pumps which deliver fluid below ambient temperature.

C. Equipment, tanks, etc., not factory insulated, shall be insulated under this section.

D. Expansion tanks and similar equipment not receiving fluid directly from the system do not require insulation.

E. Valves, traps, pressure reducing valves, pumps, convertors, expansion joints, etc.: Extend insulation 6 inches beyond flanges.

F. Systems above Ambient Temperature: 2-inch-thick glass fiber insulation with vapor barrier.

G. Systems below Ambient Temperature: ½ inch thick glass fiber insulation with vapor barrier. Exception: Insulate pump bodies on systems below ambient temperature with 1-inch-thick cellular foam insulation.

H. All equipment requiring access for maintenance, repair or cleaning shall be insulated with lace-on blankets.

Insulation Schedule - Piping					
System	**Operating Temperature (degrees F)**	**Insulation Type**	**Pipe Size (inches)**	**Minimum Insulation Thickness (inches)**	**Notes**
Heating Hot Water	105 to 140	glass fiber k = .21 - .28	Under 1 ½	1	—
			1 ½ and greater	1.5	
Refrigerant	40 to 60	cellular foam k = .22 - .28	Under 1 ½	1	—
			1 ½ and greater	1.5	
Notes:					

Insulation Schedule – Ductwork Basis: Idaho State Energy Code (IECC 2018) and ASHRAE 90.1 2013						
Duct Systems	**Duct Location and Use**	**Climate Zone**	**Minimum Installed Duct Insulation Value**	**Insulation type**	**Insulation Thickness**	**Notes**
Supply air or return Air	Outside the building (outdoors and exposed to weather)	5	R-12	Glass Fiber, rigid or Polyiso-cyunarate rigid	3”	1, 2
Supply air	Within the conditioned space	5	R-3.0	Glass fiber, flexible duct wrap	1.0”	1, 2

Insulation Schedule – Ductwork Basis: Idaho State Energy Code (IECC 2018) and ASHRAE 90.1 2013						
Duct Systems	**Duct Location and Use**	**Climate Zone**	**Minimum Installed Duct Insulation Value**	**Insulation type**	**Insulation Thickness**	**Notes**
Supply air	Within the conditioned space and directly serves that space and is exposed to view	5	none	none	n/a	1, 2
Relief or exhaust air	Within the conditioned space downstream of an energy recovery media, upstream of an automatic shut-off damper	5	R-6	Glass fiber, flexible duct wrap	2.2”	1, 2
Relief or exhaust air	Within the conditioned space and downstream of an automatic shut-off damper	5	R-19	Glass fiber, flexible duct wrap	7”	1, 2
Outside air Ductwork, Combustion Intake Air, Flue Gas Venting Ductwork	Within the conditioned space and upstream of automatic shut-off damper to HVAC unit or room	5	R-19	Glass fiber, flexible duct wrap	7”	1, 3, 4
Outside air ductwork and Combustion Air Venting/Ductwork	Within the conditioned space and downstream of automatic shutoff damper to HVAC unit or room	5	R-6	Glass fiber, flexible duct wrap	2.2”	1,3
Portable Exhaust Unit Permanent Duct (See 3/M302)	Within the building envelope	N/A	_	Fire rated duct insulation	1-1/2”	

Insulation Schedule – Ductwork Basis: Idaho State Energy Code (IECC 2018) and ASHRAE 90.1 2013						
Duct Systems	**Duct Location and Use**	**Climate Zone**	**Minimum Installed Duct Insulation Value**	**Insulation type**	**Insulation Thickness**	**Notes**

Notes:

1. When ductwork is indicated to be lined on the drawings, provide 1” duct liner. Lined ductwork inside the conditioned space may have duct wrap reduced by 1.5 inches in thickness. In some instances, duct liner may be indicated on the plans to be greater than 1 inch thick for acoustical purpose and in these instances provide thickness indicated.
2. Where round or oval ductwork is indicated to be lined on the drawings, Provide duct insulation lining and interior protective liner in accordance with Section 23 31 00.
3. Ducts shall have continuous vapor barrier control from the building exterior to the automatic shutoff damper or heating or cooling equipment.
4. Combustion air and flue venting ductwork connected to all boilers, gas fired unit heaters, and water heaters (CPVC) shall be 7” thick R-19 glass fiber.

END OF SECTION

SECTION 23 08 00

COMMISSIONING OF HVAC SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Attention is directed to the printed form of Contract and General Conditions and Supplementary Conditions which are hereby made a part of this Section of the Specifications.

B. Furnish all labor, materials, equipment and services necessary to provide the owner with fully functional HVAC systems.

C. Commissioning: Commissioning (Cx) is a quality-oriented process for achieving, verifying, and documenting that the performance of facilities, systems, and assemblies meet the defined objectives and criteria set by the Owners.

D. Commissioning Team: The members of the Cx team consist of the owner's contracted commissioning authority (CxA), the owner's representative or construction manager (CM), the general contractor (GC), the architect (Arch) and the design engineers (Engs), the mechanical Contractors (MC), the electrical contractor (EC), the testing and balancing (TAB) contractor, the control contractor (CC), the facility operating staff, and any other subContractors or suppliers of equipment. The CxA directs and coordinates the project Cx activities and reports to the owner. All team members work together to fulfill their contracted responsibilities and meet the objectives of the contracted documents. Commissioning Shall:

1. Verify that applicable equipment and systems are installed according to the contract documents, manufacturer's recommendations, and industry accepted minimum standards and that they receive adequate operational checkout by installing Contractors.

2. Verify and document proper performance of equipment and systems.

3. Verify that O&M documentation left on site is complete.

4. Verify that the owner's operating personnel are adequately trained.

E. The Cx process does not take away from or reduce the responsibility of the system designers or installing Contractors to provide a finished and fully functional product. Furthermore it doesn't not remove any responsibilities, products or requirements of other specification sections. This includes equipment startup by manufacturer trained personnel.

F. The general or HVAC contractors are not required to provide the CxA. An independent, third party commissioning agent has been retained by the State of Idaho. Though the contractor is not required to provide a commissioning agent,

requirements for participation in the commissioning process are included in this specification.

1.2 DESCRIPTION OF WORK

A. The work of this Section shall include and provide all labor, tools, materials and equipment necessary for the CxA to verify installation and performance of the HVAC and Controls systems.

1.3 RELATED WORK IN OTHER SECTIONS & REFERENCED STANDARDS

A. The following related work shall be furnished or performed under other Sections of these Specifications:

1. Section 019113 – GENERAL COMMISSIONING REQUIREMENTS

2. Section 019114 – COMMISSIONING PLAN

B. Commissioning Plan documentation is included by reference for information only.

C. ASHRAE Standard 202-2018

D. IECC 2018

1.4 DEFINITIONS

A. Commissioning Plan: The detailed set of checking and testing procedures, sequences of events, schedules, staffing plans, and management or administrative procedures required to provide a comprehensive coordinated approach for commissioning the systems and equipment described herein.

B. CxA: Commissioning Authority. The Commissioning Representative of the Owner. The Commissioning Authority will manage all commissioning activities on behalf of the Owner and will serve as the Owner’s agent in review and approval of commissioning related services.

C. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

D. Systems Pre-Functional Test: A test, or tests, of the static function and operation of equipment and systems using manual (direct observation) by the installing contractor prior, during and post-equipment startup as deemed appropriate. Systems Pre-Functional Performance Testing is meant to verify the as-built systems ability to operate trouble free in at least a limited fashion prior to TAB and Systems Functional Performance testing. This process is documented through population of the provided pre-functional checklists.

E. Systems Functional Performance Test: A test, or tests, of the dynamic function and operation of equipment and systems using manual (direct observation) or

monitoring methods meant to commence following the completion of TAB and Systems Pre-Functional Testing. Systems Functional Performance Testing is the dynamic testing of systems (rather than just components) under full operation (e.g., the hot water pumps are tied to a control system which are governed by control sequences as applied through the DDC system) performed by the Commissioning Agent with support from the contractor as needed. Systems are tested under various modes, such as low and high demand conditions, component or power failures, etc. The systems are run through all the control system's sequences of operation and components are verified to be responding as the sequences state. Traditional water test and balancing (TAB) is not considered Systems Functional Performance Testing. TAB's primary work is setting up the system flows and pressures as specified, while System Functional Performance Testing is verifying that the system has already been set up properly and is functioning in accordance with the Construction Documents. The Commissioning Agent develops the Systems Functional Performance Test Procedures in a sequential written form, coordinates, witnesses, and documents the actual testing. Systems Functional Performance Testing is performed by the CxA with assistance by the installing contractor and TAB contractor. Systems Functional Performance Tests are performed after startups, control systems are complete and operational, TAB functions and Pre-Functional Checklists are complete.

F. Commissioning Representatives: Those members of the Contractor's staff, Subcontractor's staff, Owner's staff, Architect's staff, or Owner's independent contractor assigned to participate in the commissioning process.

G. Commissioning Manager: The Commissioning Representative of the Contractor and/or commissioning team, to manage and lead the commissioning effort on behalf of the Contractor and/or commissioning team.

H. Commissioning Procedures: A series of checks, tests, and operational procedures, applied in specific sequences, to each system or equipment component to be commissioned and intended to demonstrate full system installation, performance, and functionality, in accordance with the design intent. The term "procedures" shall be used throughout this specification and the Project Commissioning Plan in reference to these checking, testing, and operational procedures.

1.5 INTENT

A. It is the intention of this Specification is to require the Contractors performing work to cooperate with the CxA, to furnish all labor and equipment and measuring devices, to perform required measurements and tests to verify that the installed equipment and systems are performing in accordance with the construction documents.

B. The CxA is not responsible for design concept, design criteria, compliance with codes, design or general construction scheduling, cost estimating or construction management.

C. HVAC system installation, start-up, testing and balancing, preparation of O&M manuals, and operator training are the responsibility of the HVAC Contractor, with coordination by the General Contractor, Construction Manager or other

entity acting under the requirements of Division 1. Observation, verification and Cx are the responsibility of the CxA who is to be assisted by installing Contractors in system operation as needed. The Cx process does not relieve Contractors from the obligations to complete all portions of work in a satisfactory and fully operational manner, nor does Cx remove any obligation the trades have for operation and maintenance manuals and training.

1.6 HVAC CONTRACTOR REQUIREMENTS

A. Cx, Pre-Functional and Functional testing as defined by ASHRAE standard 202-2018 are mandatory requirements of this project. All equipment and systems installed in connection with the section listed above shall be put in operation in the presence of duly authorized representatives with 24-hour notice given to the CxA.

B. All applicable equipment submittals shall be forwarded to the CxA for review.

C. No Functional Testing shall commence until the completion and submission of the manufacturer startup checklists and populated pre-functional checklists to the CxA. The CxA will provide blank pre-functional testing forms for the contractor to populate. Pre-functional testing forms shall be provided to the CxA in submittal form.

D. No Functional Testing shall commence until all systems TAB is complete. Functional testing may commence, at the discretion of the CxA, once TAB is complete however only conditional acceptance can be achieved until the final TAB report is provided by the contractor to the CxA for review. Only after review and acceptance of the TAB report and tested values can final acceptance be achieved. The owner may elect to wait until final acceptance is achieved to consider the project substantially complete.

E. The Cx responsibilities applicable to mechanical contractor and appropriate subcontractors are as follows:

1. Provide startup by manufacturer trained personnel for all equipment in the contracted scope.

2. Assist and cooperate with the Testing and Balancing (TAB) contractor and the CxA by:

a. Putting all equipment and systems into operation and continuing the operation during each working day of TAB and Cx as required.

b. Including cost of sheaves, belts, and filter changes that may be required by TAB.

c. Providing clearances for test holes in ducts and plenums where directed by TAB to allow air measurements and air balancing.

d. Providing temperature and pressure taps according to the Construction Documents for TAB and Cx testing.

e. Assist the TAB in the location and operation of all volume, control, and fire/smoke dampers.

3. List and clearly identify on the as-built drawings the locations of all P/T plugs, air-flow stations gauges, meters, sensors and all other such measure and verification devices.

4. Prepare a preliminary schedule for all pipe and duct system testing, flushing and cleaning, equipment start-up and TAB start and completion for use by the CxA. Update the schedule as appropriate.

5. Notify the GC when pipe and duct system testing, flushing, cleaning, power distribution and startup of each piece of equipment and TAB will occur. Be responsible to notify the GC, ahead of time, when Cx activities not yet performed or not yet scheduled will delay construction. Be proactive in seeing that Cx processes are executed and that the CxA and GC both have the scheduling information needed to efficiently execute the Cx process.

6. Attend Cx scoping meetings and other meetings necessary to facilitate the Cx process.

7. Provide a copy of the O&M manuals and submittals of commissioned equipment, through normal channels, together during equipment submittals to the CxA for review and approval. See this specification section for additional information and requirements for the O&M manuals.

8. Contractors shall assist (along with the design engineers) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.

9. Review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.

10. Develop a full start-up and initial checkout plan using manufacturer's start-up procedures and the PFTs from the CxA for all commissioned equipment. Submit to CxA for review and approval prior to startup.

11. During the startup and initial checkout process, execute the Mechanical related portions of the PFTs for all commissioned equipment. Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the CxA.

12. Address current outstanding issue log items before functional testing. Air and Water Pressure Testing and Air & Water Testing and Balancing

(TAB) shall be completed with discrepancies and problems remedied before functional testing of the respective air- or water-related systems.

13. Complete Prefunctional Test Checklists (PFTs) provided by the CxA and return these to the CxA.

14. Provide access for equipment to be tested, such as removing ceiling tiles.

15. Provide skilled technicians to execute starting of equipment and to execute the pre-functional performance tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem solving.

16. Provide skilled technicians to assist with functional performance testing under the direction of the CxA for specified equipment outlined in the Cx Plan. Assist the CxA in interpreting the monitoring data, as necessary.

17. Correct deficiencies (differences between specified and observed performance). The CxA will provide one (1) functional retest of commissioned equipment at no additional charge to the contractor(s). If repeated failures of the equipment and/or system require retest beyond the first retest, the contractor (s) will be back charged for the time of the CxA required to complete the additional retesting.

18. Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions. Provide assistance, cooperate and provide required materials to others as directed by the GC (and CxA) in the compilation of the O&M manuals. Prepare draft versions of the O&M Manual for use as the training syllabus.

19. During construction, maintain as-built red-line drawings for all drawings and final as-builts for contractor-generated coordination drawings. Update after completion of Cx (excluding deferred testing).

20. Provide Training Plan and training of the Owner’s operating staff using expert qualified personnel, as specified. Use the draft O&M manual as the training manual.

21. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.

22. Attend Cx coordination meetings and provided assistance and cooperate in the preparation of a Cx schedule with the GC and CxA.

23. Cx Tasks shall be performed by the same personnel who were involved in the installation and are familiar with the equipment.

24. During the Warranty Period execute seasonal or deferred functional performance testing, witnessed by the CxA, according to the

specifications and correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

F. The Cx responsibilities applicable to the TAB Contractor in addition to those which apply in (A) are as follows:

1. Prior to starting TAB, submit to the GC the qualifications of the site technician for the project as required by division 23 specifications. The owner, EOR and/or CxA will approve the site technician's qualifications for this project.

2. Meet with the CxA and GC and submit the outline of the TAB plan and approach for each system and component to the CxA, GC and the controls contractor prior to starting TAB. The submitted plan will include:

a. Certification that the TAB contractor understands the Cx requirements.

b. An explanation of the intended use of the building control system for TAB. The controls contractor will comment on feasibility of the plan.

c. All field checkout sheets and logs to be used that list each piece of equipment to be tested, adjusted and balanced.

d. Discussion of what notations and markings will be made on the duct and piping drawings during the process.

e. Final test report forms to be used.

f. Procedures for TAB work for each system and issue: terminal flow calibration (for each terminal type), diffuser proportioning, branch / submain proportioning, total flow calculations, rechecking, diversity issues, expected problems and solutions, etc. Criteria for using air flow straighteners or relocating flow stations and sensors will be discussed. Provide the analogous explanations for the water side.

g. Details of how *total* flow will be determined

h. The identification and types of measurement instruments to be used and their most recent calibration date.

i. Specific procedures that will ensure that water systems are operating at the lowest possible pressures and provide methods to verify this.

j. Details regarding specified deferred or seasonal TAB work.

k. Details of any specified false loading of systems to complete TAB work.

l. Plan for hand-written field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).

3. Provide a draft TAB report within two weeks of completion. A copy will be provided to the CxA. The report will contain a full explanation of the methodology, assumptions and the results in a clear format with designations of all uncommon abbreviations and column headings. The report should follow the latest and most rigorous reporting recommendations by AABC, NEBB or ASHRAE Standard 111.

4. Provide the CxA with any requested data, gathered, but not shown on the draft reports.

5. Provide a final TAB report for the CxA with details, as in the draft.

1.7 RESPONSIBILITY OF THE THIRD-PARTY COMMISSIONING AUTHORITY

A. Organize and lead the Cx team.

B. Prepare a construction-phase Cx plan. Collaborate with Contractors and with subContractors to develop test and verification procedures. Include design changes and scheduled Cx activities coordinated with overall Project schedule. Identify Cx team member responsibilities, by name, firm, and trade specialty, for performance of each Cx task.

C. Review and comment on submittals from Contractors for compliance with the OPR, BOD, Contract Documents, and construction-phase Cx plan. Review and comment on performance expectations of systems and equipment and interfaces between systems relating to the OPR and BOD.

D. Convene Cx team meetings for the purpose of coordination, communication, and conflict resolution; discuss progress of the Cx processes. Responsibilities include arranging for facilities, preparing agenda and attendance lists, and notifying participants. The CxA shall prepare and distribute minutes to Cx team members and attendees within five workdays of the Cx meeting.

E. At the beginning of the construction phase, conduct an initial construction-phase coordination meeting for the purpose of reviewing the Cx activities and establishing tentative schedules for operation and maintenance submittals; operation and maintenance training sessions; TAB Work; and Project completion.

F. Observe and verify construction and report progress and deficiencies. In addition to compliance with the OPR, BOD, and Contract Documents, verify systems and equipment installation for adequate accessibility for maintenance and component replacement or repair.

G. Prepare project-specific test and verification procedures and checklists.

H. Schedule, direct, witness, and document tests and verifications.

I. Compile test data, verification reports, and certificates and include them in the systems manual and Cx report.

J. Develop custom pre-functional and functional testing protocol for review by interested parties.

K. Perform functional testing with assistance by appropriate contractors.

L. Certify date of acceptance and startup for each item of equipment for start of warranty periods.

M. Review project record documents for accuracy. Request revisions from Contractor to achieve accuracy. Project record documents requirements are specified in Division 1.

N. Review and comment on operation and maintenance documentation and systems manual outline for compliance with the OPR, BOD, and Contract Documents. Operation and maintenance documentation requirements are specified in Division 1.

O. Review operation and maintenance training program and provide assessment and feedback on the completeness of the maintenance training program requirements. Operation and maintenance training is specified in Division 1.

P. Assemble the final Cx documentation, including the Cx report and Project Record Documents.

1.8 SYSTEMS TO BE COMMISSIONED

A. HVAC System

1. Makeup Air Systems
2. Air Handling System
3. Exhaust Fans
4. Destratification FanS
5. Boilers
6. Pumps
7. Terminal Units, re-heat water coils, valves, actuators and controls.
8. General Hydronic and Airside Systems infrastructure including piping, ductwork, insulation, fittings, etc.
9. Unit Heaters
10. Local and DDC based controls
11. Installation Quality
12. Overall HVAC Functionality

B. No Functional Testing shall commence until all Prefunctional Checklists are completed and returned to the CxA.

1.9 RECORD DRAWINGS

A. Record drawings shall be kept on the job site and up dated continuously by the Contractor as the work progresses

B. Record drawings shall show exact locations and sizes of all the work to be concealed. Especially note the location of the valves, volume dampers, fire dampers, etc.

C. Non-availability of the updated record drawings or inaccuracies therein shall be grounds for cancellation and/or postponement of any final verification by the Engineer.

1.9 COMMISSIONING APPROACH

A. General

1. The commissioning approach shall include a series of checks, tests, and operational procedures, applied in specific sequences, to each system or equipment component to be commissioned.

2. The contractor shall perform startup tests in accordance with manufacturer's requirements and pre-functional testing in accordance with Commissioning Authority supplied checklists utilizing members of the construction staff and representatives of the equipment and system manufacturer's who are fully knowledgeable of the equipment and systems installation and operation.

3. The HVAC contractor is required to fill out the pre-functional testing forms provided by the Commissioning Agent. The Commissioning agent may observe certain pre-functional tests and their discretion.

4. The specific commissioning procedures required are described in the Project Commissioning plan. These procedures shall be performed in a specific sequence as described in the Project Commissioning Plan. The sequenced application of the procedures is intended to provide a step-wise development, proceeding from the individual component level, to the system level, and ultimately to the multiple integrated level of system operation. This sequencing approach will require certain procedures to be performed earlier in the construction process than for non-commissioned construction, and is intended to help ensure that the installation is free of defects at the earliest opportunity, allowing increased time for correction or modification if defects or performance issues are found.

PART 2 - PRODUCTS

2.1 Test Equipment

A. Each subcontractor shall furnish all the equipment and labor to perform the systems and equipment installed under their section. For example, the mechanical and electrical Contractors shall ultimately be responsible for all standard testing equipment for the mechanical, lighting and power systems, controls systems, plumbing systems except for equipment specific to and used by TAB in their Cx responsibilities.

B. Stand-alone datalogging equipment shall be provided by the CxA as needed.

C. BMS/DDC tied datalogging equipment and software can be used for Cx at the discretion of the CxA and shall be considered the property of the Owner.

D. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications. All equipment shall be calibrated according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates readily available where applicable.

E. Refer to the Cx Plan for details regarding equipment that may be required to simulate required test conditions.

PART 3 - EXECUTION

3.1 SUBMITTALS

A. Contractors shall provide submittal documentation for systems to be commissioned indicated herein and in the Cx Plan.

B. Mechanical contractor shall provide documentation that that includes results of static testing as required by all Division 23 specifications.

C. Mechanical Contractor shall provide all manufacturer based pre-startup, startup and other equipment specific pre-testing documentation.

D. Mechanical Contractor shall provide populated prefunctional checklists.

3.2 PRE-COMMISSIONING WORK SESSION & KICKOFF MEETING

A. The mechanical subcontractor shall participate in the pre-commissioning work session to review the CxA's developing Commissioning Plan. The work session shall be held prior to Lighting rough-in.

B. The work session shall be held at the Contractor's principle place of business or at the job site. The GC, CxA, appropriate subcontractors and representatives of the owner shall be scheduled for attendance as a minimum. Sub-contractor representatives of the principle trades involved in the commissioning process should also be in attendance and may be scheduled for attendance at the discretion of the CxM.

C. The GC shall record participant comments and distribute minutes of the meeting to all parties involved.

D. The GC shall schedule and chair a commissioning kickoff meeting review the CxA's testing protocols, revisit the commissioning plan and review scheduling for upcoming testing. The work session shall be prior to startup of major equipment.

E. The GC shall schedule and the appropriate subcontractors shall participate in the kickoff meeting held separately from the work session.

F. Mechanical contractor(s) shall participate in both the work session and kickoff meeting.

3.3 STARTUP

A. The HVAC contractor(s) shall follow the start-up and initial checkout procedures listed in the Responsibilities list in this section and in the Cx Plan. Division 23 has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents and manufacturer requirements. The Cx procedures and pre-functional and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the CxA, GC or Owner.

3.4 CONTROLS TESTING PREPARATION AND VERIFICATION

A. The Cx responsibilities of the Controls Subcontractor in preparation for Functional Testing are:

1. Sequences of Operation Submittals: The Controls Contractor shall send to the CxA complete controls submittals. Submittals of control drawings shall include complete detailed sequences of operation for each piece of equipment, regardless of the completeness and clarity of the sequences in the specifications. See Division 1 for complete details.

2. Points List: The Controls Contractor shall send to the CxA a draft points list as soon as it is available but no later than two months prior to occupancy. This shall be updated as often as required. A complete "as-built" points list shall be sent at the end of the project. See Division 1 for complete required contents of the points list.

3. Point-To-Point Checks – The Controls Contractor is required to perform their own point-to-point checks and provide verification to the CxA prior to the HVAC contractor scheduling functional testing.

4. Notification of Operation: The Controls Contractor shall notify the CxA when each piece of equipment, panel or sub-panel is under automatic control and may be viewed in operation, prior to final functional testing.

5. The Controls Contractor shall review all CxA provided functional test procedures. The receipt of the procedures by the contractor constitutes certification that the contractor has reviewed the procedures and confirmed they are safe and will not harm any equipment or systems. Any subsequent damage incurred as a result of conducting the documented verification shall be the responsibility of the contractor.

3.5 TAB

A. Refer to the TAB responsibilities above and in the TAB specification section.

3.6 PRE-FUNCTIONAL TESTING

A. Prior to the beginning of the commissioning and testing specified under this section, the HVAC subcontractor adjust and check operation and performance of the systems and equipment installed under their respective sections.

B. At the discretion of the CxA the sub systems may be required to be tested prior completion of the entire system. This particularly applies to hydronic systems pressure testing.

C. Submit to the CxA all the testing logs.

D. Without limiting the following work shall be performed:

1. Verify and document that the systems and equipment are installed and functioning in accordance with the OPR and contract documents. The as-built drawings and operating manuals reflect the as built conditions.

2. The systems shall be started and their performance shall be checked and compared with the manufacturers requirements as well as design documents.

3. Blank Pre-functional checklists shall be provided by the CxA.

4. Any system or equipment which is does not pass manufacturer startup requirements and Pre-functional testing shall be repaired and replaced at no cost to the owner. The contractor shall retest the system at their own cost until the manufacturers startup requirements and pre-functional testing criteria are met.

3.7 FUNCTIONAL TESTING

A. After review and acceptance of the manufacturer startup forms and pre-functional checklists, the CxA will schedule dates to begin functional testing.

B. Functional testing is intended to begin upon completion of a system installation, startup and pre-functional testing. Functional testing may proceed prior to the completion of systems or sub-systems at the discretion of the CxA and Owner. Beginning system testing before full completion does not relieve the Contractor from fully completing the system, including all PFTs as soon as possible.

C. Procedure Acceptance
1. On-Site Conditional Acceptance

2. Upon satisfactory completion of each commissioning procedure and completion of the procedure close-out meeting, the CxA shall provide conditional acceptance of the procedure.

3. Conditional acceptance shall indicate that the related installation work checked by the procedure and the related performance verified by the procedure is satisfactory, and that the required procedure has been completed, only.

4. Conditional acceptance shall not imply that the equipment and systems involved with the procedure are fully approved and have been provided with final acceptance. Conditional acceptance shall additionally be subject to all notes and comments included in the field notes or test forms, and subject to the satisfactory demonstration that all associated pre-testing, special testing, special testing reports, or alignment reports have been fully completed.

5. Conditional acceptance shall be indicated by the signature of the CxA on the functional testing form.

D. On-Site Procedure Rejection

1. The CxA shall have the authority to reject a procedure in its entirety or to cause the procedure to be stopped if in the opinion of the CxA, any of the following conditions exist:

   a. The pre-procedure review meeting is incomplete.

   b. Appropriate or sufficient contractor staff is not available or required commissioning representatives are not present.

   c. Required pre-testing or report data, such as point-to-point control verifications, alignment reports, and trend log data is not available or is incomplete.

   d. The installation is insufficient or incomplete as required for the procedure or not in compliance with the Contract Documents.

   e. Numerous checks or tests fail or cannot be accomplished.

   f. Installation and/or operation of equipment or systems beyond or in advance of the commissioning requirements.

   g. Installation, operation, or commissioning not in compliance with the sequencing requirements.

   h. Indication of improper maintenance or operation.

   i. Inadequate instrumentation

2. The CxA shall additionally reject a procedure and require the equipment operation or procedure to be stopped if in the opinion of the CxA unsafe

conditions to either staff or equipment exist. Consideration of safety issues by the CxA shall not in any way relieve the Contractor from his sole responsibility for job site safety and protection of the equipment.

3. Direction to stop the procedure or halt the operation of equipment will be given verbally. Upon notification the Contractor shall immediately stop the procedure and restore the system or equipment to a safe condition.

4. At the discretion of the CxA, the Contractor may be afforded the opportunity to correct the conditions indicated by the CxA and resume the procedure.

5. If in the opinion of the CxA corrections cannot be implemented in a satisfactory manner, within the scheduled time available for the procedure and with sufficient time available to complete the procedure, the procedure shall be stopped and rescheduled by the CxM. The CxA shall provide the CxM with written notification of procedure rejection stating the cause of the action.

6. The Contractor shall be liable for all actual costs associated with the required attendance by the CxA, the Owner's and A/E's commissioning representatives, and required outside agents, resulting from rejected procedure.

7. Actual costs shall include:

    a. Cost for the CxA and for each Owner's and A/E's commissioning representative, which are comprised of contractual billing rate as defined in the respective organization's agreement for such work, including overhead and profit. For CxA and A/E's commissioning representatives, these rates may be found in the A/E schedule for additional services.

    b. Travel-related expenses for the CxA and for each Owner's or A/E's commissioning representative, where such staff is required to be in attendance and not headquartered within the city limits, which are comprised of compensation for actual travel time, with an established minimum of 5 hours, and mileage rates, billed at the prevailing national government rate.

    c. Costs assessed for required outside agents, contractors, or specialists employed by the Owner or A/E at the actual contractual billing rates as defined in the respective organization's agreement for such work.

    d. Equipment rentals, special tools, and related material fees associated with the participation of contracted outside organizations and specialists.

8. The costs assessed will be documented by the CxA and will be deducted from the Contractor's fees or progress payments at the time of occurrence.

3.8 FINAL ACCEPTANCE

A. Final acceptance will be contingent upon satisfactory completion of all commissioning tasks and submittals, with final review and approval by the Commissioning Authority.

B. Where specific components, equipment, or system elements are unable to comply with the specified requirements due to improper or incomplete installation, product defect, or failure of a device to perform to the manufacturer’s published or advertised capabilities, final acceptance will be contingent on repair, replacement, and correction of the deficiencies by the Contractor and satisfactory completion of the commissioning procedures.

C. Where specific components, equipment, or system elements are demonstrated to comply with the specified requirements and perform to the manufacturer’s published or advertised capabilities, but are demonstrated not to provide the performance as required by the Contract Documents and the commissioning procedures, disposition of the issue and/or related modifications shall be provided as directed by the Architect. Final acceptance shall be contingent on the completion of any resulting correction work and related commissioning requirements determined as necessary in final disposition of the issue.

D. Upon satisfactory completion of all commissioning work and resolution of all related issues, the CxA shall provide the Owner, Contractor, and the Architect with a final report documenting recommendation for final acceptance. Recommendation for final acceptance by the CxA shall indicate that in the opinion of the CxA, and as demonstrated within the extent and scope of the commissioning process, the equipment and systems have been installed in compliance with, and function as required by the Contract Documents.

E. The Owner may accept the recommendation of the CxA and provide final acceptance by providing the appropriate authorized signature and by providing copies of the signed acceptance to all parties involved. The Owner’s final acceptance of the commissioning work shall indicate that Owner accepts that the systems and equipment, as demonstrated within the extent and scope of the commissioning process, have been installed in compliance with, and function as required by, the Contract Documents. The Owner’s acceptance shall not constitute agreement that all contractual obligations are fulfilled and does not constitute final acceptance of the project under the terms and conditions of the Contract Documents.

END OF SECTION

SECTION 23 09 23

DIRECT-DIGITAL CONTROL FOR HVAC

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Energy Management and Control System (EMCS)

B. Air Measuring Stations

C. Water Flow Meter

D. Control Valves

E. Controllers

F. Temperature Control Dampers

G. Uninterruptible Power Supply (UPS)

H. General Components

1.2 RELATED SECTIONS

A. Section 22 05 23 – General Duty Valves for Plumbing Piping

B. Section 22 10 00 – Plumbing Piping

C. Section 23 05 00 – Common Work Results for HVAC

D. Section 23 05 23 – General Duty Valves for HVAC Piping

E. Section 23 05 53 – Identification for HVAC Piping and Equipment

F. Section 23 05 93 – Testing, Adjusting, and Balancing

G. Section 23 09 95 – Variable Frequency Drives

H. Section 23 21 13 – Hydronic Piping

I. Section 23 21 23 – Hydronic Pumps

J. Section 23 23 00 – Refrigerant Piping

K. Section 23 25 00 – HVAC Water Treatment

L. Section 23 33 00 – Air Duct Accessories

M. Section 23 36 00 – Air Terminal Units

N. Section 23 52 16 – Condensing Boilers

O. Section 23 73 00 –Central Station Air Handling Units

P. Section 23 81 03 – Packaged Ventilation Air Handling Units

Q. Section 23 82 00 – Convection Heating and Cooling Units

R. Section 26 05 33 – Raceways and Boxes

1.3 REFERENCES

A. UL 916 - Underwriters Laboratories Standard for Energy Management Equipment

B. NEC - National Electrical Code

C. City, county, state, and federal regulations and codes in effect as of date of purchase

1.4 DESCRIPTION

A. The specification is intended to cover equipment, labor, materials and services sufficient to result in a complete Energy Management and Control System (EMCS) capable of controlling and monitoring the complete mechanical system with owner training as outlined in the drawings and in these specifications.

B. EMCS contractor shall be responsible for all EMCS and temperature control wiring for a complete and operable system. All wiring shall be done in accordance with all local and national codes and Division 26. This includes all low voltage wiring as well as line voltage wiring required for control power purposes.

1.5 SUBMITTALS FOR REVIEW (REFER TO SECTION 23 05 00)

A. General
   1. Drawings shall be standard sizes: 8½×11 inch, 11×17 inch, 24×36 inch.

B. Provide temperature controls submittals with the following tabbed sections:
   1. Statements of Conformance Section
      a. Statement of Conformance: The temperature controls submittal shall be accompanied by a statement of conformance by the temperature controls supplier. This statement of compliance shall indicate that the EMCS, as installed, will meet all of the requirements of these specifications. If the EMCS is not capable of meeting each requirement of these specifications, this statement of compliance shall indicate each individual requirement that cannot be met, the impact this might have on the system, and proposed methods of equivalent compliance.
      b. Statement of Native BACnet Conformance: The temperature controls submittal shall be accompanied by a separate statement of native BACnet conformance by

the temperature controls supplier. This statement of compliance shall indicate that the EMCS, as installed, will meet all of the requirements of the specified conformance class of native BACnet architecture. Included with this statement shall be Protocol Implementation Conformance Statements (PICS) for each applicable component necessary to demonstrate compliance.

2. Floor Plan Wiring and Component Section
   a. Provide floor plans that indicate the location of primary control components such as operator work stations, equipment controllers/main panels, unitary (terminal unit) controllers, and associated controlled equipment (boilers, chillers, air handlers, etc.).
   b. Provide a network communications (LAN) wiring diagram showing connectivity between control devices.
3. System Interface Section
   a. Provide graphic systems schematics and flow diagrams.
   b. Provide a complete points list, indicating the plain English description that will be utilized in EMCS programming and the type of point (analog input, analog output, digital input, digital output).
   c. Provide a complete list of adjustable points, including range of adjustment and initial setting.
   d. Provide a complete list of alarms, including level of alarm and resulting action.
   e. Provide a description of the sequences of operation as understood by the controls contractor. This description shall be in the general format of the programming for the controls system, but shall be in narrative form. Copied sequences from the control diagrams are not acceptable.
4. System Wiring Diagram Section
   a. Provide a system schematic layout showing all operators' terminals, equipment controllers, unitary controllers, equipment and systems interface devices, etc. as required for a complete system. The equipment served by each device shall be indicated in the schematic. Individual inputs and outputs shall not be included in this schematic. Each device shown in this schematic shall be cross-referenced to both the individual component schematic as well as the submittal information for that device type. Wiring between devices shall also be cross-referenced to its submittal information.
   b. Provide individual component schematics for each controller. These schematics shall indicate each device input and output. The available number and type of spare points for each controller as installed as well as the expandability of the device shall be indicated in the schematic.
5. EMCS Software Section
   a. At a minimum, this section shall address each requirement noted in these specifications for the EMCS software.
6. Graphical User Interface Section
   a. Provide a representation of the graphical penetration scheme as outlined in these specifications. This can be in the form of a simple flow diagram.
   b. Provide a representation of how points and schedules are accessible through the graphical interface.
   c. Provide a representation of how the system programming is accessible through the graphical user interface.
   d. Provide information on the graphics development package.
   e. Provide graphic floor plan displays for all spaces. Include a representation of each of the required space temperature indicators.

f. Provide a table of occupied heating, occupied cooling, unoccupied heating and unoccupied cooling setpoints for each temperature control zone. Setpoint criteria shall be obtained from the owner prior to submission of submittals. This table shall be a verification of these criteria.
g. Provide a table of the warm-up/pre-cool, occupied and unoccupied scheduling for each temperature control zone. Scheduling criteria shall be obtained from the owner prior to submission of submittals. This representation shall be a verification of these criteria.

7. Web Browser Interface Section
   a. At a minimum, this section shall address each requirement noted in these specifications for the EMCS software.
8. Interface Wiring Diagrams Section
   a. Provide schematics for each point of interface to other systems or packaged equipment controls.
   b. For interfaces not specified to receive integration devices, provide the following at a minimum:
      1) Schematics showing the location of all terminal strips and/or connection points between systems (including room designation, location within room, control panel designation, etc. as appropriate).
      2) Notation of contractor responsible for hardware (terminal strips, contacts, etc.), wiring and terminations.
      3) A description of each point including plain English functional description, electrical characteristics (0 to 10 V, 4 to 20 mA, N/O dry contact, N/C dry contact, etc.).
   c. For interfaces specified to receive integration devices, provide the following at a minimum:
      1) Schematics showing the location of the integration device (including room designation, location within room, control panel designation, etc. as appropriate).
      2) Notation of contractor responsible for integration device, wiring and terminations.
      3) A description of the information that will be transferable through the integration device, including read/write capabilities.
   d. Each schematic shall be reviewed, approved and noted as such by both the temperature controls contractor and an authorized agent of the system or equipment requiring interface.
   e. At a minimum, a wiring diagram shall be provided for each interface noted in the Systems and Equipment Interfaces section of these specifications.
9. Components Section
   a. Provide submittal information for each system hardware component, including the operator's terminal, all controllers, required systems and equipment interface devices, measurement and control devices. Measurement devices shall include units of measurement, range of measurement and accuracies.
   b. Provide a control damper and damper actuator sizing schedule.
   c. Provide a control valve sizing schedule.
   d. Provide a complete recommended spare parts list for the controls system.

C. Submit a Material Safety Data Sheet (MSDS) for each sealant, adhesive, coating, paint in accordance with Section 23 05 00.

1.6 PROJECT RECORD DOCUMENTS (REFER TO SECTION 23 05 00)

A. Provide “as-built” documentation of all information required for original system and equipment submittals as outlined above. Information shall be included in the operation and maintenance manuals as outlined below.

B. In addition to inclusion in the operation and maintenance manuals, the points list, adjustable points list, and alarm points list, as required in the systems control section of the submittals, shall be laminated in plastic after approval by Owner’s Representative. One copy shall be posted at the main control cabinet of the building and the second copy shall be given to the Owner.
   1. Points list shall identify BACnet information and address for each point for use in the future by other BACnet manufacturers.

1.7 OPERATION AND MAINTENANCE DATA (REFER TO SECTION 23 05 00)

A. The Energy Management and Controls System section shall include the following sub-sections:
   1. An individual section for each system. These sections shall include as-built documentation of the information required in the Systems Interface section of the submittals.
   2. Systems Wiring Diagrams Section. This section shall include as-built documentation of the information required in the Systems Wiring Diagrams section of the submittals.
   3. Interface Wiring Diagrams Section. This section shall include as-built documentation of the information required in the Interface Wiring Diagrams section of the submittals.
   4. Components Section. This section shall include as-built documentation of the information required in the components section of the submittals.

1.8 DELIVERY, STORAGE, AND HANDLING (REFER TO SECTION 23 05 00)

A. Store products in shipping containers in clean, dry location until installation.

B. The Contractor shall be responsible for his work and equipment until finally inspected, tested, and accepted. The Contractor shall protect any material that is not immediately installed. The Contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

1.9 SEQUENCING AND SCHEDULING

A. Complete the 96-hour test run (see Part 3 of this section) prior to test and balance.

B. Pre-balance inspection and adjustment of the control systems shall be performed by the control engineer in the presence of the Engineer. This operation shall be performed prior to the start of the air and water balance work. Pre-balance inspection and adjustment shall include adjustments of all controls and devices as required to prove sequence of operation in all control modes. A written report, signed by participating parties shall be forwarded to the Owner’s Representative with a copy enclosed in the O&M manual.

C. The temperature controls contractor shall assist the balancing agency as required for proper balancing of the systems with assistance as required in Section 23 05 93. Furnish a hand-held controller or laptop service tool for the balance agency use during test and balance. This tool shall be returned to the EMCS Contractor at the end of test and balance.

D. The temperature controls contractor shall assist the commissioning agency as required for proper commissioning of the systems. Furnish a hand-held controller or laptop service tool for the commissioning agency use during commissioning. This tool shall be returned to the EMCS Contractor at the end of commissioning.

E. Final adjustments and calibration of systems and components, including valve and damper operators, shall be accomplished after balancing has been completed and prior to O&M instruction period. This shall include any required setting of controls or labeling of setpoints. The EMCS Contractor shall coordinate scheduling and setpoints with Owner's Representative. A letter of certification, stating the above has been completed and signed by the EMCS Contractor shall be forwarded to the Owner's Representative with a copy enclosed in the O&M manual. The Owner's Representative shall be notified, in writing, two (2) weeks in advance of scheduled time to witness sequence of operation on all systems. All systems shall be fully operational at the time of this demonstration.

F. See Section 23 05 00 for additional requirements.

1.10 COORDINATION WITH OTHER TRADES

A. It is the responsibility of the EMCS contractor to communicate all specific needs for proper installation and operation of the EMCS system to all other necessary trades and to verify that those provisions will be made under the terms of this contract without additional cost to the owner.

B. Coordinate closely with other subcontractors and equipment suppliers to ensure that equipment is provided with features necessary to interface with the EMCS system.

C. Coordinate and schedule work with all other work in the same area or with work which is dependent upon work by other trades to facilitate mutual progress.

D. The EMCS Contractor's designated project engineer/manager shall attend the regularly scheduled construction meetings as requested by the General Contractor in response to current construction activities and shall be familiar with the technical aspects of the EMCS design and capabilities.

1.11 NATIVE BACNET SYSTEM REQUIREMENTS

A. The system shall be modular in nature and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, equipment controllers, unitary controllers, and operator devices while re-using the existing controls equipment.

B. The EMCS shall utilize native BACnet architecture as referenced by ANSI/ASHRAE Standard 135-most recent edition.

C. The communication network between controllers shall be BACnet. All controllers shall utilize native BACnet architecture and shall be independently tested and listed through BACnet Testing Laboratories. See http://www.bacnetassociation.org/btl.

D. All points need to be configured so that a “future” BACnet vendor can read/write to all points from a central Owner Work Station for such tasks that would include, but not be limited to, changing setpoints, making adjustments and scheduling of equipment.

1.12 SYSTEMS AND EQUIPMENT INTERFACES

A. General: Provide interfaces/integration with these microprocessor-based systems and packaged equipment as indicated on the control drawings. Coordinate closely with the respective subcontractors and their equipment suppliers to ensure that the necessary interface is provided with each piece of equipment.

1.13 COMMISSIONING REQUIREMENT

A. See Section 23 05 00 for commissioning requirements related to this section of work.

1.14 ENERGY CODE COMPLIANCE

A. The EMCS shall comply with all requirements of the current Idaho Energy Code. The following list is not meant to be all inclusive. Code references are included.
   1. Deadband control providing at least 5°F within which the supply of heating and cooling energy to the zone is shut off or reduced to a minimum.
   2. Thermostatic setback to operate the system to maintain zone temperatures down to 55°F or up to 85°F.

PART 2 - PRODUCTS

2.1 ENERGY MANAGEMENT AND CONTROL SYSTEM (EMCS)

A. Native BACnet System Manufacturers (Refer to Section 23 05 00 and this section paragraph 1.9 A).
   1. Schneider Electric as installed by Utah-Yamas Controls.

B. Existing Operator’s Terminal Interface
   1. The campus utilizes an existing Schneider Electric ethernet based BAS interface system. The new scope of work shall be tied into the existing ethernet based BAS interface for visibility of all new equipment as required by the control diagrams.

C. Uninterruptible Power Source
   1. Uninterruptible Power Supply (UPS): Provide a UPS for the head-end BAS equipment within the building only.

D. EMCS Software
   1. General

a. The EMCS contractor shall provide all software required for efficient operation of the EMCS system. Software shall be modular in design to provide maximum flexibility, expansion, and future revision of the system. All functionality described herein shall be regarded as a minimum.
b. The Owner shall be furnished with an unlimited site software license so that they may install an unlimited amount of software on their computers to run and operate the building. At the end of the one (1) year warranty, the Owner shall be provided with software upgrade to match the current version offered by the control manufacturer at no additional charge.
c. 32-bit software application compatible with the specified operating system; multi-tasking type environment that allows the user to run several applications simultaneously.

2. Control Algorithms: The system shall have the ability to perform the following pre-tested control algorithms: Two-position control, proportional control, proportional plus integral control, proportional, integral, plus derivative control, and automatic tuning of control loops.
3. Operator Access: Different security levels shall be assignable to each operator. Each command and event shall be capable of being assigned a security level. Access to commands, acknowledgment of alarms, etc. shall be limited in accordance with the operator's security level designation.
4. Password Protection: Multiple operator-specific password access protection shall be provided to allow the user/manager to limit workstation control.
5. Event Reporting: The operator shall have the capability to define which actions get reported in which manners, both individually and globally through grouping of events (initially, a minimum of three (3) reporting groups shall be designated: urgent alarms, general alarms, and general messages). Reported events shall include a time and date stamp, site location and network address, and alpha-numeric event ID. Any one or combination of the following event reporting actions shall be assignable to each event: ASCII file, numeric pager (pages personnel by sending numeric messages to personal pagers through the use of a third-party service), printer, and operator's terminal.
6. Trending: Any point, physical or calculated, shall be capable of trending. Collection of data shall be definable by either pre-defined time intervals or pre-defined changes of value. Trending information from anywhere in the system shall be available at the operator's terminal without requiring intervention by an operator.
7. Scheduling: The system shall be capable of scheduling by zone, individual equipment, groups of zones or equipment, building area, and systems. Equipment or zone groups shall be definable by the operator. Weekly schedules shall incorporate seven (7) independent daily programs. System shall also incorporate one-time and annual event scheduling. The system shall automatically update for daylight savings time and leap years. Schedules shall be capable of being overridden at the operator's terminal.
8. Optimum Start/Stop: Start and stop equipment on a sliding schedule based on the individual zone temperature and the heating/cooling capacity of the equipment serving that zone. The heating/cooling capacity value shall be operator adjustable.
9. Source Temperature Optimization: Automatically perform source temperature optimization for all equipment noted to have temperature setpoints reset by system demand in the control diagrams. Capability shall include resetting of temperature setpoints in accordance with user-adjustable parameters as well as starting and stopping of primary mechanical equipment based on zone occupancy and/or zone

load conditions. Temperature optimization loops shall be tuned to minimize cycling and maximize system stability.

10. Demand Limiting: The system shall be capable of measuring electrical usage from multiple meters serving one building. Each piece of equipment being controlled shall be programmable to respond to peak demand information. The demand control function shall utilize a sliding window method with the operator being able to establish the kilowatt threshold for a minimum of three (3) adjustable demand levels. The operator shall have the capability to set the individual equipment temperature setpoints for each operator defined demand level. Equipment shall not be shed if these reset setpoints are not satisfied. The system shall have failed meter protection, generating an alarm upon loss of KW signal. System shall archive demand and usage information. Information shall be retrievable by day, month-to-date and year-to-date basis.
11. Night Setback: The system shall allow the space temperature to drift down or up within an adjustable unoccupied temperature range. Heating and/or cooling shall be controlled to maintain the night setback range during the scheduled night setback periods.
12. Timed Local Override: When provided with occupant override capabilities the system shall permit the override of equipment which has been scheduled off. Override history shall be maintained for each timed local override input point. Local override shall allow system operation for up to 2 hours.
13. Economizer: The system shall be capable of switchover from mechanical cooling to economizer cooling based on outside air temperature. Economizer operation shall be capable of being overridden by the operator.
14. Power outage: Programmable controls shall be capable of retaining their programming and time setting during a loss of power for at least 10 hours.
15. Connectivity: The system shall be capable of monitoring zone level information such as temperature, pressure, valve position etc. and transferring that information to equipment controllers to effect sequence of operations.

E. Graphical User Interface

1. Floor Plan and System Selection/Penetration: The operator interface shall allow users to access the various system schematics and floor plans via both a graphical penetration scheme and menu selection.
   a. Graphical penetration scheme: Multiple floor plan displays, when required, shall all be accessible from a single initial screen. System schematics shall be directly accessible from the floor plan display for the area they serve. For zoned systems, both the zone and main system schematics shall be accessible from the floor plan display. For systems that interact with secondary systems and/or equipment (e.g. an air handling unit with a hot water coil served by a heating water system), the secondary system and/or equipment shall be accessible from the primary system schematic. It is the intent of this graphical penetration scheme that, from a single screen, any location served by the system can be accessed and, from any floor plan display, all systems and/or equipment serving that area can be accessed.
   b. Menu selection: A menu selection shall also be available to the operator, similar in nature and layout to the graphical penetration scheme described above.
2. Floor Plan Displays: Provide color graphic floor plan displays designating each temperature control zone. Each zone shall have a graphic and color-coded indication of space temperature relative to setpoint, with a minimum of five (5) different indicators (e.g. dark blue, light blue, green, yellow, red).

3. System Schematic Displays: Provide color graphic system schematics for all mechanical equipment and systems. Schematics shall be similar in nature to the control diagrams included in the drawings. Each system and/or equipment schematic shall include the following minimum information:
   a. System designation
   b. Graphic representation and labeling of all major equipment and components (all scheduled equipment as a minimum)
   c. Current status of all I/O points applicable to the system (located appropriately for ease of proper association)
4. System Setpoint and Scheduling Adjustments: All system setpoints and schedules shall be adjustable through the graphic interface. This includes all space temperature setpoints, occupied/unoccupied/warm-up schedules, and all points noted in the control diagrams as adjustable. Adjustments shall require only mouse operation and entering of new values. Changes shall be automatically transferred to the appropriate control module.
5. Windowing: The windowing environment of the operator's terminal shall allow the user to simultaneously view several graphics at the same time to analyze total building operation, or to allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.
6. Programming Accessibility: Programming for sequences of operation shall be accessible through the graphical user interface.
7. Setpoint Accessibility: Each setpoint and/or item indicated in the control diagrams to be adjustable shall be accessible and capable of being modified through the graphical user interface.
8. Graphics Development Package: Graphic generation software shall be provided to allow the user to add, modify, or delete system graphic displays.
   a. The contractor shall provide libraries of pre-engineered screens and symbols depicting standard HVAC components (e.g. fans, cooling coils, filters, dampers, etc.) and electrical symbols.
   b. The graphic development package shall use a mouse or similar pointing device in conjunction with a drawing program to allow the user to perform the following:
      1) Define symbols
      2) Position and size symbols
      3) Define background screens
      4) Define connecting lines and curves
      5) Locate, orient and size descriptive text, define and display colors for all elements
      6) Establish correlation between symbols or text and associated system points or other displays
   c. Graphical displays can be created to represent any logical grouping of system points or calculated data based upon building function, mechanical system, building layout, or any other logical grouping of points which aids the operator in the analysis of the facility. To accomplish this, the user shall be able to build graphic displays that include point data from multiple DDC panels, including application specific controllers used for DDC unitary or VAV terminal unit control.

F. Web Browser Interface
   1. Compatibility: The system shall be capable of supporting an unlimited number of clients using Internet Explorer. Web browser software shall be compatible with the operating system and system configuration provided.

2. Consistency with GUI: Graphical screens developed for the GUI shall be the same screens used for the web browser client. Any animated graphical objects supported by the GUI shall be supported by the web browser interface. The browser shall provide the same view of the system as the graphical user interface including graphics, schedules, calendars, logs, etc. and shall provide the same interface methodology as the GUI. Systems that require different views or that require different means of interacting with objects such as schedules or logs will not be permitted.
3. Security: User identification and password security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented. Limitations of user access and control similar to that provided at the operator's terminal shall be assignable to each user.
4. Editing Capabilities: HTML editing by the operator shall be allowed, but not be required for proper operation.
5. Graphics Storage: Graphical screens shall be stored in the server. Systems that require graphics storage on the client machine are not acceptable.
6. Real-Time Data Displays: Values displayed on the web page shall update automatically without requiring a manual refresh of the web page.
7. Links: Graphical screens on the web browser client shall support hypertext links to other locations on the Internet or on Intranet sites through the Uniform Resource Locator (URL).

2.2 DAMPER AND VALVE ACTUATORS

A. Manufacturers (Refer to Section 23 05 00):
1. Belimo, for air handling unit dampers and other system control dampers.
2. As manufactured by approved EMCS manufacturer, for control valves and air terminal unit dampers. Manufacturers who do not have valves and air terminal unit dampers labeled under the Manufacturer's name shall provide Belimo actuators.

B. High resolution type with positive feedback on valve or damper position, direct coupled type.
1. Spring-return operation to fail open or closed upon loss of signal or power when indicated on the drawings as normally open (NO) or normally closed (NC), respectively; constructed to maintain last position upon power failure when not specified to be either normally open or normally closed on the drawings.
2. Built-in overload protection to prevent damage to the actuator when the actuator or damper reaches its end position.
3. Designed for a minimum life of 60,000 cycles; selected for compatibility with associated equipment.
4. Damper actuators sized for 50 % safety factor with ample capacity to hold device at an intermediate position.
5. Valve actuators sized for torque required for valve close-off at maximum pump differential pressure. Valve actuators shall be factory installed on the valves with necessary hold off brackets and shields to protect the actuator from condensation and over-heating.
6. Actuator unit shall be submerged in oil and sealed in die cast case; UL listed; 3 year unlimited warranty.

C. Signals
1. All actuators shall utilize analog actuators.
2. Exceptions:

a. Air terminal units (air and valve actuators) and hydronic valve actuators serving terminal units (½" and smaller) may utilize floating point actuators.

2.3 AIRFLOW MEASURING STATION (THERMAL SENSING STYLE)

A. Manufacturers (Refer to Section 23 05 00):
   1. Ebtron
   2. Schneider Electric
   3. Paragon Controls

B. Sensor shall consist of multiple probes which utilize thermal dispersion technology with a pressure drop not to exceed 0.05 inches WG at 2,000 FPM with 2 % accuracy between 0 to 5,000 FPM.

C. Probes: Basis of Design, Ebtron Model GP-1. Gold anodized 6061 aluminum probe, hermetically sealed "bead in glass" thermistor sensors, glass filled polypropylene sensor housing, 304 stainless steel duct mounting brackets, plug and play cable in length to suit application.

D. Transmitter: 24 VAC, 20 V-A max power which is fused and protected on the transmitter, display CFM (with area input).

E. Network Configuration: Basis of Design, Ebtron GTX-116-P transmitter with 9600 baud RS485 serial output in BACnet Protocol, interface includes airflow or velocity.

F. See schedule on drawings for approximate duct sizes and airflows.

G. Submittals: Submit installation instructions with product data. After approval by Owner's Representative, forward a copy to the installing contractor (Section 23 33 00).

2.4 WATER FLOW METER

A. Manufacturers (Refer to Section 23 05 00):
   1. Onicon
   2. Schneider Electric

B. Insertion type turbine flow meter designed for "hot tap" installation on systems filled with fluid or, alternately, provide with an insertion meter installation kit complete with thread-o-let nipple and full port valve for installation on systems with no fluid in the system.
   1. Basis of Design: Onicon F1100 Series Single Turbine Flow Meters for steel pipe 1 ¼" and larger and copper pipe 1" and larger for single directional flow where straight pipe run is long enough to produce a fully developed flow profile.
   2. Basis of Design: Onicon F-1300 Series Inline Turbine flow meters for pipe sizes ¾".

C. Pipe size and flow rate as indicated on the drawings.

D. Materials- Hot Water (to 280 degrees F)
   1. 316SS for heating water over 250 degrees F.
   2. 316 SS for non-metallic Pipe

E. Performance and Options
1. Wetted parts shall be bright tin plated brass or Type 316 stainless steel.
2. Sensing method shall be impedance sensing, nonmagnetic and non-photoelectric.
3. Accuracy ±2 % of actual reading from 0.4 to 20 FPS.
4. 400 psi (maximum operating pressure).
5. 200 degrees F (maximum continuous liquid temperature).
6. Non-isolated analog output signals, 0 to 10 VDC and 20 mA, linear with flow. Binary (digital) dry contact output for bi-directional flow meter.
7. 24 VDC power supply.
8. Hot tap installation to include branch outlet tapping, close nipple, full port ball valve and hot tap adapter.
9. Local display shall be LCD with BACnet interface. Display to suit application:
   a. BTU applications: System 10 (LCD display that displays energy, flow and temperature data)
   b. Flow applications: Series D-1200 or BD-1200 (bi directional flow)
10. Provide with temperature sensors for monitor of energy in addition to flow when indicated on control drawings.

2.5 CONTROL VALVES

A. Manufacturers (Refer to Section 23 05 00):
1. As manufactured by approved EMCS manufacturer, or approved by the Owner's Representative.

B. 2-way or 3-way as indicated on the drawings

C. Ball or butterfly valves of suitable construction for intended application in accordance with the manufacturers recommendations

D. Throttling plugs and renewable composition seats

E. Stainless steel ball and stems

F. Suitable for close-off pressure differential equal to the total head of the respective circulating pump or system steam pressure

G. Provided with manual positioning capability to allow manual positioning of valve in absence of control power

H. Sized by the control contractor for a 4 psi maximum pressure drop

I. Ball valves (up to 2"):
1. Basis of Design: Belimo B2/3 series characterized control valves.
2. Stainless steel ball and stem.
3. Forged brass, nickel plated body
4. PTFE Seat
5. EPDM O ring
6. Temperature rating: 0 to 250 degrees F.
7. Pressure rating: 400 psi minimum
8. Close-off pressure: 200 psi
9. Maximum differential pressure: 50 psi

J. Butterfly valves (2 ½" and larger):
   1. Basis of Design: Belimo F6/7 HD series Trim
   2. Stainless steel disc
   3. Ductile iron body
   4. EPDM liner
   5. 0% leakage to 50 psi

K. Pressure rating: 125 PSI minimum working pressure.

2.6 CONTROLLERS

A. Manufacturers (Refer to Section 23 05 00):
   1. As manufactured by approved EMCS manufacturer.
   2. Equipment Controllers
      a. Stand-Alone Operation: Integral processor, software, hardware, firmware, and memory sufficient to perform complete stand-alone control and operation of associated equipment.
      b. Expansion: Controllers shall accommodate multiple I/O expansion modules for the possibility of future expansion.
      c. Operator's Terminal Interface: All point data, algorithms and application software within a controller shall be custom programmable from the operator's terminal.
      d. Self-Diagnostics: Each controller shall include self-diagnostics, which allow the controller to automatically notify the network controller of any malfunctions or alarm conditions that exceed desired parameters.
      e. Operator's Interface: Each controller shall contain a port for connection of a portable computer. The entire system shall be accessible from this port.
   3. Unitary Controllers
      a. Stand-Alone Operation: Upon loss of communication, each unitary controller shall execute its assigned control algorithm in a stand-alone mode.
      b. Zone Temperature Sensor Compatibility: Unitary controllers shall support various types of zone temperature sensors including temperature sensor only, temperature sensor with setpoint adjustment, temperature sensor with local override switch, and temperature sensor with setpoint adjustment and local override switch.
      c. For applications that require airflow measurement, the unitary controller shall include a precision built-in differential pressure transducer. The differential pressure transducer shall have a measurement range of 0 to 4,000 FPM and measurement accuracy of ±5 % at 400 to 4,000 FPM. Controller shall include provisions for manual and automatic calibration of the differential pressure transducer. Automatic calibration shall occur whenever the system mode switches from occupied to unoccupied bode or vice versa.
      d. VAV Applications: Unitary controller shall be provided with either a separate or integral direct-coupled electronic actuator. The actuator shall be of the on-off floating point control. The actuator assembly shall mount directly to the damper operating shaft. The actuator shall be electronically protected against overload.
         1) Provide serviceable air filter in tubing to VAV controller for airflow sensing technology that uses a flow through device that exposes instrumentation to room air.
      e. Serviceability: Controller wiring terminal bars shall be of detachable type allowing quick serviceability of the electronic controller hardware without removal of the existing wiring.

2.7 OCCUPANCY SENSORS

A. Manufacturers (Refer to Section 23 05 00):
   1. As manufactured by approved EMCS manufacturer.

B. Basis of Design: SpaceLogic RP-C-EXT-IS-BLE

C. Other sensors manufactured by the EMCS manufacturer may be allowed, if approved by the Owner.

D. Multi-sensor connects to the room controllers and is used for infrared motion detection.

E. Power and communications through the room bus.

F. People counting through thermal image sensor with software configurable detection areas.

G. Motion detection through passive infrared sensor.

H. Sensor: Quad-type passive infrared (PIR) sensor with Fresnel lens.

I. Sensor range shall be 26 feet, when mounted at 9 feet elevation.

2.8 TEMPERATURE CONTROL DAMPERS

A. Manufacturers (Refer to Section 23 05 00):
   1. Air Balance
   2. American Warming
   3. Ruskin
   4. Delta Control Products – Class I
   5. Tamco

B. Class 1-Low Leak, Galvanized, Air Foil
   1. Basis of Design: Ruskin CD-60
   2. General: Low-leak, airfoil design; galvanized; parallel blade for return air applications and opposed blade for outside and exhaust air applications or as indicated on the drawings.
   3. Construction
      a. Galvanized steel, 16 gage hat channel frame.
      b. Galvanized steel, 14 gage airfoil blades, single piece.
      c. Extruded vinyl double edge blade seals, easily replaceable; self-lubricating stainless steel sleeve bearings.
      d. Square or hexagonal axles for positive locking (round is not acceptable). Plated steel.
      e. Linkage concealed in frame.
   4. Leakage: AMCA certified for leakage. Maximum leakage for dampers between 12 and 60” wide shall be no greater than 4 cfm per square foot at 1” wg.

2.9 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. Manufacturers (Refer to Section 23 05 00):
   1. Liebert
   2. APC
   3. CyberPower

B. Basis of Design: SeriesAPC UPS 750 VA Line Interactive or approved equal

C. Provide an UPS for the the direct digital controls system (DDC) microprocessor front-end. The UPS shall have an output to the EMCS to alarm the system of normal power loss and recovery.
   1. UPS unit shall provide thirty (30) minutes of system operation in the event of 120 volt normal power loss for any reason.
   2. The UPS unit shall normally provide power from the battery/inverter source while the battery is under continuous charge by the normal 60 Hz AC power. In the event of an overload on the inverter, the UPS shall automatically and instantaneously transfer from battery/inverter mode to normal 60 Hz AC power mode. When the overload is resolved, the system shall automatically and instantaneously re-synchronize and transfer from normal 60 Hz AC power mode back to battery/inverter mode. In the event of failure of the normal 60 Hz power, the transfer described above shall be initiated, even in the face of an overload. Upon restoration of the normal 60 Hz AC power, the system shall re-enable the transfer to normal 60 Hz AC power. All transfers shall occur in such a manner that they are transparent to both the user and the system except that if the normal 60 Hz AC power fails, an alarm contact closure shall be available which will reset automatically when the normal power source is restored.
   3. The UPS unit shall fully recharge backup batteries within eight (8) hours after restoration of AC primary power.
   4. Electrical requirements:
      a. 120 VAC input
      b. ±3 % max (10 % to 100 % load) regulation
      c. 5 % maximum distortion
      d. 1 Hz or 4 Hz per second slew
      e. 250:1 from line spike attenuation
      f. 86 % on line efficiency
      g. KVA rating, batteries, and output as required
   5. Overloads: 125 % for 10 minutes on bypass (to 60 Hz AC); 110 % for 10 minutes on inverter (to normal).

2.10 VARIABLE FREQUENCY DRIVES (VFD'S)

A. Furnished by the EMCS Contractor in Section 23 09 23 in accordance with Section 23 09 95.

2.11 GENERAL COMPONENTS

A. Conduit: Conduit shall meet all requirements of the Latest Edition of the National Electrical Code and State Codes and Division 26. All exposed control wiring required for operation of the controls system as required by the drawings and this specification

seciton shall be installed in conduit. Refer to specification section 26 05 33 for conduit requirements. Control wiring required of this section that is not exposed to view, above a ceiling, does not require a conduit for installation.

B. Contactors
1. Single coil, electrically operated, mechanically held type
2. Positive locking obtained without the use of hooks, latches or semi-permanent magnets
3. Doubled break silver to silver type protected by arching contact where necessary
4. Number and rating of contacts selected for the intended application
5. Operating and release times shall be 100 milliseconds or less
6. Equipped with coil transient suppression devices to limit transients to 150 % of rated coil voltage

C. Electronic Transmitters: Temperature sensing elements shall be thermistor or platinum RTD type as indicated below.

D. Enclosures: Enclosures shall conform to the requirements of NEMA 250 for the types specified. Finish color shall be the manufacturer's standard, unless otherwise indicated. Damaged surfaces shall be repaired and refinished using original type finish. Enclosures may be NEMA 1 when located in a clean dry indoor environment. Indoor enclosures shall be NEMA 12 when installed in other than a clean dry environment. Equipment installed outdoors shall be housed in a NEMA 4 enclosure. Penetrations shall be sealed to preclude entry of water using a silicone material. All control panels shall be UL listed for code compliance.

E. Nameplates: Provide laminated plastic nameplates for all equipment and monitoring and control devices in accordance with the requirements of Section 23 05 53. Each nameplate shall identify the function, such as "mixed air controller" or "cold deck temperature sensor". Nameplates shall be in accordance with the requirements of Section 23 05 53.

F. Power Conditioning
1. Capacity shall match the equipment served
2. Output 120 VAC, +6 to –8 % at 90 to 136 VAC input
3. Maximum 2 % total harmonic wave form distortion
4. 10 million to 1 common-mode noise attenuation (140dB minimum at 0.0)
5. 57dB normal-mode noise attenuation for 10 Hz to 1 MHZ
6. Provide for all solid state equipment unless protection meeting these requirements is an integral part of the equipment.

G. Relays
1. General:
   a. Rated for the intended application
   b. Minimum of 2 sets of Form C contacts
   c. Enclosed in a dust-proof enclosure
   d. Rated for a minimum life-cycle of 1,000,000 operations
   e. 20 milliseconds or less operating time
   f. 10 milliseconds or less release time
   g. Equipped with coil transient suppression devices to limit transients to 150 % of rated coil voltage

2. Enclosed Relays (Relay-in-a-Box) RIB: SPDT enclosed relays with nipple mount for panel applications with LED status pilot light.
3. DIN Socket Control Relays:
   a. Plug-in type with dust cover
   b. Contact rating, configuration, and coil voltage suitable for application
   c. UL listed
4. Time Delay Relays:
   a. Solid state plug-in type with adjustable time delay
   b. Delay shall be adjustable plus or minus 200 % from setpoint called for
   c. Contact rating, configuration, and coil voltage suitable for application
   d. NEMA 1 enclosure when not installed in local control panel

H. Sensors
1. General: Sensors and control elements shall be rated for continuous operation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified or normally encountered for the installed location.
2. Provide wall boxes for sensing elements for conduit rough-in with extension rings if required due to finished surfaces on the walls.
3. Duct Temperature Sensors: Resistor Temperature Detector (RTD) with platinum element and transmitter to match resistance range of RTD or thermistor type, accuracy of 0.1 % at 32 degrees F.
   a. Use averaging type on mixed air plenums and downstream from heating and cooling coils. Averaging type sensor encased in bendable copper sheath of the length required (normally 24 feet long). Serpentine element horizontally.
   b. Use direct insertion probe type on return air and supply air ducts. Use 4 inch long probe on terminal box discharge supply ducts. Use 12 inch long probe on main return air and supply air ducts.
4. Low Limit Thermostats (Freeze stats): Dual signal low temperature cut-out and alarm thermostat with remote sensing element. Manual reset type selected for the application. Bulb shall be approximately 20 feet long for use in large ducts or plenums and shall be designed to stop the respective fan should the temperature drop below setpoint along any one foot length of the bulb. 15 to 55 degrees F adjustable range.
   a. Provide with two sets of contacts. One to hardwire to equipment for shutdown and one for the DDC system for monitoring.
5. Outside Air Temperature Sensors: Resistor Temperature Detector (RTD) or thermistor; -20 °F to 180 °F temperature range, sun shield and weatherproof assembly for mounting to rigid conduit.
   a. Install away from exhaust/relief vents. Preference should be given to locate as near as possible to the outside air intake for the air handling equipment, but keeping it out of direct sunlight or other reflective sources that would adversely affect its accuracy. When possible the sensor should be located on the northwest outside building wall.
6. Room Temperature Sensors:
   a. 10K ohm at 77 degrees F thermistor, ±0.5 degrees F accuracy.
   b. Provide with integral communications jack to communicate with the zone's unitary controller.
   c. The contractor shall review with the Owner prior to the submittal of shop drawings the specific sensor types and features. For the purposes of the bid, sensors shall be provided as follows:
      1) Sensors in all areas:

a) Blank tamperproof covers with no display, no adjustment and no over-ride.
b) Where CO2 sensors are indicated on plans, provide with integral CO2 sensing (400 to 1250 ppm: +/- 30 ppm or 3% of reading whichever is greater) (1250 to 2000 ppm: +/- 5% of reading)

7. Immersion Temperature Sensors:
   a. 10K ohm at 77 degrees F thermistor, ±0.5 degrees F accuracy.
   b. Range as suitable for application.
   c. Provide stainless steel or brass thermowell for threaded mounting into pipe.
   d. Thermal paste shall be used in all thermowells.
   e. 4 or 8 inch insertion length depending upon pipe size and mounting configuration available (elbow, lateral or straight).
8. Pressure Sensors:
   a. Air Differential Pressure Sensors:
      1) Electronic transducer
      2) Linear variable differential transformer type sensing element with two-wire transmitter
      3) 2 % of full scale accuracy
   b. Liquid Differential Pressure Sensors:
      1) Single pole, single throw switch
      2) Bellows type
      3) Adjustable range
      4) Suitable for intended application

9. Duct mounted/outdoor Carbon Dioxide (CO2) Sensors for demand ventilation control:
   a. Non-dispersive infrared (NDIR) sensor.
   b. Continuous monitoring.
   c. 0 to 2,200 ppm measurement range.
   d. Accuracy: ±75 ppm or 7 % whichever is greater.
   e. Repeatability: ±20 ppm.
   f. Altitude correction adjustable.
   g. Output signal: Continuous proportional analog output, 0 to 10 VDC or 4 to 20mA.
   h. Factory calibrated with 5 year guarantee.
   i. Calibration: Minimum recommended 3 year interval.
   j. Furnish necessary calibration tools and gases for the test and balance agency to spot check the calibration and to demonstrate calibration to the Owner.
10. Space mounted CO2 sensors.
   a. Where required, do not provid as an integral feature to space temperature sensor. Space temperature sensor and space mounted CO2 sensors shall be separate.
   b. Field calibratable non-dispersive infrared CO2 sensor
   c. Selectable BACnet MSTP and Modbus outputs via RS-485
   d. 18-24 AWG screw terminals
   e. Sensor type: Non-dispersive infrared (NDIR), diffusion sampling
   f. Output range: 0 to 2000 ppm
   g. Accuracy: ±30 ppm ±3% of measured value
   h. Repeatability: ±20 ppm ±1% of measured value
   i. Response time: <60 seconds for 90% step change

I. Switches

1. Air Flow Switches:
   a. General purpose utilizing differential air pressure.
   b. SPDT snap-acting contracts.
   c. Adjustable from 0.1 to 2.0 inches WG minimum or as required for the intended application.
   d. Aluminum construction with neoprene diaphragm.
2. Bypass Switches:
   a. Momentary contact type push button.
   b. Installed in standard wall box with stainless steel cover.
3. Current Switches (fan and pump status):
   a. Self-powered.
   b. Solid state.
   c. Adjustable trip current; selected to match the current of the application and output requirements of the EMCS system.
   d. UL listed.
   e. Provide variable frequency drive rated current switches on motors with VFDs.
4. Damper End Switches:
   a. Momentary type limit switches for monitoring motion of the damper at a prescribed arc of rotation.
   b. Hermetically sealed mercury contacts that operate by way of a trip lever.
   c. Mounted on the exterior of the duct so that the trip lever is aligned with the damper vane.
   d. Mechanically adjustable in the switch case to set the proper lever action for tripping the mercury switch contacts.
   e. SPDT contact arrangement exceeding the load requirements for both voltage and current.
5. Air Differential Pressure Switches:
   a. Snap-acting
   b. Pilot duty rated (125 VA minimum)
   c. NEMA 1 enclosure
   d. Scale range and differential suitable for intended application
   e. UL listed
   f. Filter Status: Range 0.05 to 2.0 inches WG, adjustable, SPDT contacts, 15 amps at 277 VAC.
   g. Duct High Limit: Range 0.40 to 12.0 inches WG adjustable, SPST contacts, 15 amps at 277 VAC, manual reset.
6. Emergency Shutdown Switches:
   a. Mushroom head.
   b. Red color.
   c. Non-spring return, or break glass style if indicated on the plans.
7. Flow Switches:
   a. Air Service:
      1) Differential pressure type switches as specified above.
   b. Water Service:
      1) Paddle type switch.
      2) Snap-acting with pilot duty rating (125 VA minimum).
      3) Adjustable sensitivity.
      4) NEMA 1 enclosure.
      5) UL listed.
      6) Alternatively, differential pressure type switches as specified herein.
8. On/Off Switch:

a. Standard wall box type switch.
b. Single pole.
c. Illuminated switch with light activated when controlled device is on.
d. Stainless steel cover plate.

9. Pressure-Electric Switches:
   a. Metal or neoprene diaphragm actuated.
   b. 1- or 2-stage switch action as required by application.
   c. Open type when panel-mounted or enclosed type for remote installation.
   d. Enclosed type shall be in a NEMA 1 enclosure unless noted otherwise.
10. Three-Position Wall Switch:
    a. Standard wall box type switch.
    b. Center off position.
    c. Pole and throw to suit application.
    d. Stainless steel cover plate.
11. Water Differential Pressure Switches:
    a. General purpose liquid flow switch.
    b. SPDT snap-acting contacts.
    c. Adjustable; neoprene diaphragm.
    d. Dust-tight enclosure.
    e. 150 PSIG maximum operating pressure.
    f. 250 degrees F maximum operating temperature.

J. Sensor Wells
   1. Bronze or brass with NPT threads sized to match associated device.

K. Transformers
   1. Current Transformers:
      a. Current ratio as necessary for application.
      b. Windings completely enclosed, except for terminals.
      c. 1 % of full scale accuracy.
      d. UL listed.
   2. Voltage Transformers:
      a. 600 VAC rated.
      b. Complete with built-in fuse protection.
      c. Windings completely enclosed, except for terminals.
      d. Suitable for ambient temperatures of 40 to 130 degrees F.
      e. 0.5 % accuracy at 24 VAC.

L. Transmitters
   1. Current Transmitters:
      a. Self-powered combination split-core current transformer type with built-in rectifier and high-gain servo amplifier.
      b. Unit range as necessary for application.
      c. Internal zero and span adjustment.
      d. 1 % of full scale accuracy.
      e. UL listed.
   2. Voltage Transmitters:
      a. Self-powered single loop type.
      b. Internal zero and span adjustment.
      c. 1 % of full scale accuracy.
      d. UL listed.

M. Wiring: All wiring shall be compliant to local building codes and the NEC and Division 26 of these specifications.

PART 3 - EXECUTION

3.1 EXAMINATION

A. The project plans shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the Architect/Engineer for resolution before rough-in work is started.

B. The contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the Architect/Engineer for resolution before rough-in work is started.

C. The contractor shall examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate or if any discrepancies occur between the plans and the Contractor's work and the plans and the work of others, the Contractor shall report these discrepancies to the Engineer and shall obtain written instructions for any changes necessary to accommodate the Contractor's work with the work of others. Any changes in the work covered by this specification made necessary by the failure or neglect of the contractor to report such discrepancies shall be made by this contractor at his expense.

D. Review shop drawings for equipment being monitored by the EMCS system in the project submittal stage to ensure that equipment arrives with the proper control interface and communications protocol. Provide control integration drawings as previous indicated in part 1 submittal requirements of this section.

3.2 GENERAL

A. Installation of temperature control system and equipment shall be complete under this section. Provide all required system components and wiring necessary to accomplish the specified sequences of operation as indicated on the drawings.
   1. Exception: Components specified to be factory furnished with a particular mechanical equipment item.

B. All control devices installed in ductwork shall be positively anchored and attached to the ductwork by mechanical means. Duct access panels shall be provided for all such devices.

C. It shall be the responsibility of this contractor to provide power for all devices requiring power. Coordinate with other trades to arrange for necessary power circuits. All control devices shall obtain power from dedicated control circuits. Provide control voltage transformers for low voltage control power.

D. Wiring as used herein shall be construed as all wiring, conduits, hangers, etc., required for successful operation of the system. All wiring shall be in strict accordance with the

latest edition of the National Electrical Code and local and state electrical code requirements and Division 26.

E. Install equipment, piping, and wiring/raceways parallel to building lines wherever possible.

3.3 MOTOR CONTROLS

A. Variable Frequency Drives (VFD's)
   1. VFD's furnished in Section 23 09 23 shall be installed in accordance with the requirements of Section 23 09 95.
   2. When VFD's are provided by others or as an integral part of the equipment, the control contractor shall attend the field start up and testing of the drives that are provided by others.

B. For single phase motors, provide a 20 amp control relay in a box for EMCS start and stop in the power wiring circuit provided by Division 26.

C. For three phase motors not furnished with VFD's, unless indicated otherwise, Division 26 provides a 120 volt control voltage transformer and contactor. Control contractors shall provide a 20 amp control relay in a box to intercept the control circuit.

D. Coordinate locations of control relays and installation of work with Division 26.

E. Safety relays for equipment shutdown are provided by Section 23 09 23. This includes high static, freeze stat, etc. are furnished and installed by Section 23 09 23.

F. Relays for shutdown for fire alarm conditions are provided by Division 28.

3.4 INSTALLATION

A. Actuators: All actuators for dampers furnished with air handling units shall be furnished under this Section 23 09 23 and shipped to the air handling unit manufacturer by Section 23 09 23 contractor for factory mounting within the air handling units. Section 23 09 23 Contractor shall coordinate with the various air handling unit manufacturers as to the size and quantity of actuators required for proper control of the dampers.

B. Airflow Measuring Station: Provide in sizes and locations shown on plans.

C. Control Valves: Valves furnished under this section shall be installed under the Section associated with the piping system in which the valve is being installed. Coordinate with the appropriate piping contractor.

D. Temperature Control Dampers: Dampers furnished under this section shall be installed under Section 23 33 00. Coordinate with Section 23 33 00 contractor.

E. Controllers
   1. General: Controllers shall be installed in convenient locations directly on or immediately adjacent to the controlled equipment. If locations are not shown on the drawings, verify location with owner's representative prior to installation.

2. Equipment Controllers: Provide a dedicated controller for each air handling unit or other HVAC system.
    a. Exception: A single controller can serve multiple air handling units or systems if all points for each individual system are connected to the same system and required spare capacities are maintained as noted below. Points for a single system connected to multiple panels are unacceptable.
    b. Spare Capacity: Provide a minimum of one AI/AO/DI and DO spare point at each air handler, boiler, and chiller controller. Provide a minimum of 25 % spare capacity on each communication trunk for future use.
3. Unitary Controllers
    a. Unitary Controllers shall be provided as required. Unitary controllers serving mechanical equipment that is part of a larger system (e.g. air terminal unit controllers that are part of a VAV system) shall be connected to the EMCS through the equipment controller serving the associated system.
    b. Air terminal unit controllers furnished under this section shall be shipped to the air terminal unit manufacturer by the EMCS contractor for factory mounting. Controllers and terminal units shall be factory calibrated to provide the maximum and minimum airflow values as indicated in the schedule. Final control connection, checkout, and calibration of factory-mounted controls shall be done at the site under this section. This shall include all terminal unit controllers.

F. Occupancy Sensors
1. General: Occupancy sensors shall be installed in the following spaces:
    a. 108 Office
    b. 109 Office
    c. 110 Office
    d. 107 Break/Work
    e. 106 Office
    f. 105 Office
    g. 104 Office
    h. 112 Office
    i. 102A Break
    j. 101A Hall
    k. 101D Hall
    l. 101C Hall
    m. 120 N.M.
    n. 103 Classroom
    o. 102 Classroom
    p. Or as requested by the Owner.
2. Where a single occupancy sensor’s range or sensing square footage is not sufficient for sensing the entire space, multiple sensors shall be provided.
3. Occupancy sensors shall be hung from structure where ceilings are not provided. Where ceilings are provided, center the sensor in a ceiling tile.
4. Where multiple sensors are provided and relayed to a single terminal unit or room controller, activation of any occupancy sensor shall enable the associated HVAC system into occupied mode, or as described on the control diagrams.

G. General Components
1. Conduit: Provide as required in the wiring section in complete accordance with the applicable version of the NEC. Conduit terminations shall be free from burrs with a strain relief fitting provided.

2. Nameplates: Provide system and component labeling in accordance with the requirements of Section 23 05 53. All control components, including nameplates, except room temperature sensors shall be equipped with nameplates to identify each control component. Contractor shall submit proposed labeling list prior to installation of labels.
3. Adjustable control devices :
   a. Adjustable control devices such as sensors, switches and panels for building occupant use shall be
      1) Mounted at ADA approved heights (42-48” above finished floor).
      2) Coordinate with other local devices such as lighting controls, tackboards, relites and furniture.
   b. Provide wiring from control to device to equipment being controlled or controller.
   c. Not all sensors are shown on the floor plans and those shown are preliminary locations only. Consult control diagrams for control device requirements.
   d. The contractor shall mark all final thermostat locations on-site for approval by the Owner’s Representative prior to installation.
4. Sensors
   a. General:
      1) Mount sensors rigidly and adequately for the environment within which the sensor operates.
      2) All wires attached to sensors shall be air-sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.
      3) Duct Temperature Sensors: Averaging type sensors installed in a serpentine manner vertically across the duct. Each bend shall be supported with a capillary clip.
      4) Low Limit Thermostats: Installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip. Locate on the inlet side of air handling unit cooling coils close the outside air damper.
      5) Outside Air Temperature Sensors: Install on a north wall complete with sun shield. Verify location with the Engineer prior to installation.
      6) Pressure Sensors: The piping to the pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer.
      7) Room Temperature Sensors: Install on concealed junction boxes properly supported by the wall framing.
5. Thermometer Wells: All pipe-mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat-conducting fluid in thermal wells.
6. Transmitters
   a. Provide for all temperature and pressure sensing
   b. Serpentine transmitter and controller cap tube averaging elements in mixed air and across coil face to prevent possibility of sensing stratified air
   c. Provide access panels for temperature transmitters located in return/exhaust ductwork
7. Wiring
   a. Wiring inside control cabinets shall be dressed neatly and tied with Thomas and Betts wire ties. Plastic tooth wire ties are not acceptable.
   b. All field wiring entering control cabinets shall be labeled with Thomas and Betts self-laminating wire markers or appropriate alphanumeric labels corresponding to termination shown on the control drawings. Colored phase tape shall not be used.

c. Wiring routed from equipment shall be in a manner as to avoid injury to the wiring.
d. “Across-the hinge” wiring shall be dressed to avoid strain and abrasion. Provide spiral wrap suitable to this application.
e. Install instrumentation grounding as necessary to preclude ground loops and noise from adversely affecting equipment operations.
f. Wiring shall be enclosed in conduit in the following conditions:
    1) All wiring in mechanical/equipment rooms.
    2) Concealed wiring.
    3) Outdoor wiring.
    4) Wiring mounted on vibrating equipment such as fans and compressors. (Avoid crossing flexible connections or vibration isolation components. Where wiring leaves vibrating equipment, provide ample flexible conduit to permit normal machinery movement.)
    5) Wiring routed above ceilings.
    6) All wiring associated with smoke control system.
    7) Communication wiring.
    8) Exception:
        a) Conduit for wiring above accessible T-bar ceilings may be omitted if approved by local and state electrical code authorities.
        b) Conduit for wiring in return air plenums may be omitted if approved by local and state electrical code authorities, providing that the contractor utilize plenum rated cable.
        c) There are no exceptions for wiring associated with a smoke control system. This wiring will be in conduit.
g. All wiring requirements noted above apply to communications wiring. The following requirements are intended to be supplemental to those requirements.
    1) Communication wiring shall not be installed in raceway and enclosures containing Class 1 or other Class 2 wiring.
    2) Maximum pulling, tension, and bend radius for cable installation as specified by the cable manufacturer shall not be exceeded during installation.
    3) Contractor shall verify the integrity of the entire network following the cable installation. Use appropriate test measures for each particular cable.
    4) Provide a lightning arrestor between the lines and ground wherever a cable enters or exits a building.
    5) Communication wiring shall be installed in continuous lengths. Spliced wires are not acceptable.
    6) Grounding of coaxial cable shall be in accordance with NEC Regulations Article on Communications Circuits, Cable and Protector Grounding.

8. Fiber Optic Cabling
    a. Maximum pulling tensions as specified by the cable manufacturer shall not be exceeded during installation. Post-installation residual cable tension shall be within cable manufacturer’s specifications.
    b. All cabling and associated components shall be installed in accordance with manufacturer’s instructions. Minimum cable unjacketed fiber bend radii as specified by cable manufacturer shall be maintained.

3.5 START-UP, CALIBRATION, TESTING AND DEMONSTRATION

A. Start-up and check-out

1. Verify that all circuits, controls and devices are properly installed.
2. Check connectivity of all control points between field devices and controllers. Check and confirm all device addresses and control points.
3. Verify that all dampers and control valves operate in the correct direction.
4. Energize the controlled equipment and test for proper operation. Make all necessary adjustments, remove and replace any malfunctioning devices and retest.

B. Calibration and Adjusting
1. Calibrate all sensors and devices.
2. Submit calibration sheets to the Owner's Representative.
3. Make 3-point calibration test for both linearity and accuracy for each analog device.
4. Calibrate devices according to manufacturer's directions.
5. Adjust flow, pressure and temperature switches.
6. Stroke and adjust control valves and dampers.
7. Adjust all initial temperature setpoints.

C. Testing
1. The completed control system shall be adjusted and tested under operating conditions by a qualified technician in the employ of the EMCS Contractor.
2. Before commencing the testing, the technician shall prepare an Owner approved, itemized log for the full range of control functions for each system. The log shall be initialed by the test engineer as each test is performed.
3. When the testing is completed, the test log and a letter of certification stating that all control functions of the system have been checked and are in satisfactory operating order and in compliance with the contract documents shall be given to the Owner.

D. Programming
1. Coordinate occupied/unoccupied schedule for each unit and zone with the Owner and provide project specific schedules in the programming. Schedules shall include occupied/unoccupied modes with night setback control.
2. Coordinate occupied and unoccupied setpoints with the owner and adjust in the program. Provide a minimum of 5 degree dead band between heating and cooling setpoints. Initial settings (unless adjusted by owner) shall be as indicated on the drawings.
3. Provide staggered start-up of equipment after power outage or at morning warm-up to prevent high amp draw on building electrical service.
4. Equipment shall return to a failsafe unoccupied mode after emergency shutdown (freeze stat, fire alarm etc.) with outside air dampers close and return dampers open.
5. Provide optimized start on air distribution systems with a supply air capacity exceeding 10,000 cfm served by one or more supply fans. The control algorithm shall, as a minimum, be a function of the difference between the space temperature and occupied setpoint and the amount of time prior to the scheduled occupancy.
6. Where multiple pieces of equipment serve the same space and have multiple pieces of heating and cooling equipment, controls shall be interlocked through programming to prohibit simultaneous heating and cooling.

E. Operator's Terminal
1. All points of control shall be available at any PC connected to the web based control system.
2. Alarms shall register for equipment status or conditions out of setpoint range.

F. Demonstration

1. The complete and fully operational control system shall demonstrated to the designated Owner's personnel and project engineer upon completion of successful start-up and testing. Demonstration shall be an overview of the entire functionality of the system including the operator's terminal, the web browser interface, the graphical user interface, remote control point adjustment, scheduling procedures, overrides, alarms, unitary and terminal unit control and overall compliance with the specifications.
2. Demonstration of the system shall occur in order to verify overall compliance with the above start-up and testing.
3. Demonstration shall be prior to, and in addition to, the required operator training.

3.6 SERVICE AND TROUBLE SHOOTING

A. Perform the regularly scheduled maintenance service visits as required by Part 1 of these specifications.

B. Provide warranty service and system troubleshooting as needed during the project warranty period.

3.7 SYSTEM SCHEDULING

A. During initial set-up and programming of the control system, the EMCS Contractor shall work closely with the Owner's staff to develop and program equipment utilization schedules.
   1. Equipment utilization schedules shall allow the Owner to operate groups of equipment in occupied mode based on the use of the building through selection of the appropriate utilization schedule at the Operator's workstation. Any piece of equipment shall have the capability of belonging to more than one utilization schedule.
   2. The type and expected duration of the building activities shall dictate which mechanical systems and HVAC equipment must be operational, as well as the appropriate occupied setpoints.

3.8 96-HOUR TEST RUN

A. The 96-hour test run shall be made when all field equipment is installed and the system is calibrated and running, and when all other building systems (including drywall, windows, doors, etc.) are complete. This period is intended to demonstrate the operation of the complete building.

B. The 96-hour test run shall include performance of all associated software and hardware operations called for in these specifications. The test shall be for a duration of 96 continuous hours with no Contractor maintenance required. The pre-balance conference shall not be scheduled until this test has been completed satisfactorily (i.e. run without errors or alarms for a continuous 96-hour period). Notify Owner's Representative prior to beginning the 96-hour run test.

3.9 CONSTRUCTION IAQ MANAGEMENT PLAN

A. Refer to Section 23 05 00 for supplemental information regarding cleaning and flushing.

B. Flush out shall occur after construction ends with all interior finishes installed with the building fully cleaned.
1. The preference shall be for cleaning and flushing to occur prior to occupancy.
2. If flush out is not fully completed prior to occupancy, contact the Owner's project representative to make provisions for partial flush out prior to occupancy and continuing flush out during initial occupancy.

C. During flush out the Building Automation Contractor shall set-up systems to ensure that:
1. Supply fans (and return fans where applicable) shall operate continuously, 24 hours a day for the duration specified in Section 23 05 00.
2. Where applicable, terminal boxes shall be controlled to a fixed percentage of peak flow (calculated by AHU fan peak airflow divided by the sum of peak airflow at the terminal boxes.)
3. Control the systems to maintain a minimum space temperature of 60 degrees Fahrenheit and a maximum RH of 60%. Outside air shall be limited if minimum temperatures cannot be maintained.
4. Trend and totalize the volume of outside air delivered to the space for each system during the clean/flush cycle.

3.10 COMMISSIONING REQUIREMENTS

A. Refer to Section 23 05 00 and Division 01.

B. Assist with set up of trend logs required by the commissioning agent.

PART 4 - SEQUENCE OF OPERATIONS

4.1 SEE CONTROL DIAGRAMS ON DRAWINGS FOR REQUIRED SEQUENCE OF OPERATION.

END OF SECTION

SECTION 23 09 95

VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Variable Frequency Drives to be furnished by Section 23 09 23 in accordance with this section unless specified or scheduled to be factory furnished with the particular mechanical equipment item.

B. This specification is to cover a complete Variable Frequency Drive (VFD) consisting of a pulse width modulated (PWM) inverter designed for use with both asynchronous and permanent magnet motors.

C. 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). Drives that are manufactured by a third party and "brand labeled" shall not be acceptable.

1.2 RELATED SECTIONS

A. Section 23 05 00 – Common Work Results for HVAC

B. Section 23 05 13 – Common Motor Requirements for HVAC Equipment

C. Section 23 09 23 – Direct-Digital Control for HVAC

D. Section 23 73 00 – Central Station Air Handling Units

E. Division 26

1.3 SUBMITTALS

A. Submit in accordance with Section 23 05 00. Submittals shall include the following information:
   1. Outline dimensions, conduit entry locations and weights. Customer connection and power wiring diagrams.

B. Complete technical product description with complete list of options provided. Any portions of this specification not met must be clearly indicated or the supplier and contractor shall be liable to provide all additional components required to meet this specification.

1.4 STANDARDS AND GUIDELINES

A. Institute of Electrical and Electronic Engineers (IEEE): IEEE 519-2014

B. Underwriters Laboratories (as appropriate): UL 508, 508A, 508C, UL 61800, 61800-5-1, 61800-5-2, UL 1995

C. The Association of Electrical Equipment and Medical Imaging Manufacturers (NEMA): NEMA ICS 7-2014, Adjustable Speed Drives

D. International Electrotechnical Commission (IEC): EN/IEC 61800

E. National Electric Code (NEC): NEC 430.120, Adjustable-Speed Drive Systems

F. CSA Group: CSA C22.2 No. 274

G. International Building Code (IBC): IBC 2018 Seismic – referencing ASCE 7-16 and ICC AC-156

1.5 QUALITY ASS7URANCE

A. Drives shall be UL labeled as a complete assembly. The base VFD shall be UL listed for 100 kA SCCR when installed in accordance with the manufacturer's guidelines.

B. The base drive shall be CE and meet EN 61800-3 for the First Environment restricted distribution (Category C2).

C. 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.

D. Product Support
1. Factory trained support personnel shall be locally available at both the specifying and installation locations. A toll free 24/365 technical support line connected to factory support personnel located in the US and Canada shall be available.
2. Factory training of support personnel shall include installation, programming and operation of the drive, bypass and network communications.

E. Service
1. Manufacturer shall maintain a service center or service representative within 150 miles of the job site. This center must normally provide the following services:
   a. Factory coordinated start-up service.
   b. Perform service calls and providing replacement parts within twenty-four (24) hours.
   c. Provide service contracts.
   d. Training of customers in operation and basic troubleshooting.
   e. Maintaining a stock of frequently replaceable parts at a local warehouse.

1.6 WARRANTY

A. Warranty shall be provided for the greater duration of the two following conditions:
   1. Warranty required in Divisions 00 and 01
   2. The drive Product Warranty shall be 30 months from the date of shipment from the factory. 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.

PART 2 - PRODUCTS

2.1 VARIABLE FREQUENCY DRIVES (FULLY FEATURED)

A. Manufacturers (refer to Section 23 05 00):
   1. ABB, ACH 580 Series

B. Application/Use: All drives.

C. 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.

D. The drive shall provide full rated output from a line of +10% to -15% of nominal voltage. The drive shall continue to operate without faulting from a line of +25% to -35% of nominal voltage.
   1. Unless scheduled otherwise on the drawings, drives shall be capable of continuous full load operation under the following environmental operating conditions:
      a. Ambient temperature -15 to 40° C (5 to 104° F).
      b. Altitude 0 to 1000 m (0 to 3,300 ft) above sea level.
      c. Humidity 5 to 95%, non-condensing.

E. 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.
16. The drive shall be able to support a Bluetooth Advanced Control Panel. The Bluetooth control panel shall be FCC and QDL (Qualified Design Listing) certified.
    a. A free app (iOS and Android) shall replicate the control panel on a mobile device or tablet. The control panel's programming and control functionality shall function on the device. Customizing text, such as AHU-1 End Switch, shall be supported by the device's keyboard.
    b. Bluetooth connectivity shall allow uploading, downloading, and emailing of parameter sets.

c. Bluetooth connectivity shall include two pairing modes: Always discoverable with a fixed passcode, and manual discovery with a unique generated passcode every pairing.
d. The Bluetooth antenna shall be in the control panel. Antennas that are integrated in the drive's control board, must include an external antenna, on all drives mounted inside cabinets.
e. Bluetooth connectivity shall be capable of being switched off.

F. All drives shall have the following hardware features/characteristics as standard:
1. Two (2) programmable analog 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 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. Six (6) programmable digital inputs. All digital inputs shall be programmable to support both active high and active low logic, and shall include adjustable on/off time delays. The digital input shall be capable of accepting both 24 VDC and 24 VAC.
4. 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.
5. Drive terminal blocks shall be color coded for easy identification of function.
6. The drive shall include an isolated USB port for interface between the drive and a laptop. A non-isolated USB port is not acceptable.
7. An auxiliary power supply rated at 24 VDC, 250 mA shall be included.
8. At a minimum, the drives shall have internal impedance equivalent to 5% to reduce the harmonics to the power line. 5% impedance may be from dual (positive and negative DC link) chokes, or AC line reactor. Drives with only one DC link choke shall add an AC line choke integral to the drive enclosure.
   a. On select projects, additional harmonic mitigation will be required. Reference the drive schedule to determine if additional harmonic mitigation is required for the system to comply with IEEE 519-2014. Additional harmonic mitigation, if required, will be identified by the project electrical engineer.
9. 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.
10. 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. The minimum current rating shall meet or exceed the values in the NEC/UL table 430.250 for 4-pole motors.
11. 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.
12. Circuit boards shall be coated per IEC 60721-3-3; Chemical gasses Class 3C2 and Solid particles Class 3S2.
13. Earth (ground) fault detection shall function in both modulating (running) and non-modulating modes.

14. Surge protection device provided in accordance with UL 14449.
15. 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).
16. 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.
17. All VFD's shall include EMI/RFI filters. The onboard filters shall allow the VFD assembly to be CE Marked and the VFD shall meet product standard EN 61800-3 for the Second Environment restricted level with up to 100 feet of motor cable. No Exceptions. Certified test reports shall be provided with the submittals confirming compliance to EN 61800-3, Second Environment.

G. 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, MWh, and GWh units of measurement. Power meters that only display kWh and roll over or "max out" once the maximum kWh value is reached, are not acceptable. There shall be resettable and non-resettable total power meters within the drive.
      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. 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.
13. 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.
14. Three (3) programmable critical frequency lockout ranges to prevent the drive from operating the load continuously at an unstable speed/load.
15. Seven (7) programmable preset frequencies/speeds.
16. Two independently adjustable accel and decel ramps with 1 – 1800 seconds adjustable time ramps.
17. 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.
18. 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.
19. 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.
20. 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.
21. 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. Drive faults shall be defined in Critical and Low priority groups. Critical faults shall stop the drive. Low priority faults shall be reset. Reset trials and timing shall be programmable.
f. The drive shall be configurable to receive from 1 to 3 discrete digital input signals and operate at up to three discrete speeds.

22. 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

H. 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. A checksum feature shall be used to notify the owner of unauthorized parameter changes made to the drive. The checksum feature includes two unique values assigned to a specific programming configuration.
    a. One checksum value shall represent all user editable parameters in the drive except communication setup parameters. A second checksum value shall represent all user editable parameters except communication setup, energy, and motor data parameters.
    b. Once the drive has been commissioned the two values can be independently saved in the drive.

c. The drive shall be configurable to either: Log an Event, provide a Warning, or Fault upon a parameter change when the current checksum value does not equal the saved checksum value.

4. The “Hand” and “Off” control panel buttons shall have the option to be individually disabled (via parameter) for drives mounted in public areas.
5. The capability to disable Bluetooth on control panels that include Bluetooth functionality shall be provided.

I. 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. Optional communication cards for BACnet/IP, LonWorks, Profibus, Profinet, EtherNet/IP, Modbus TCP, and DeviceNet shall be available. The use of third party gateways are not acceptable.
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 embedded BACnet connection shall be a MS/TP interface. The drive shall be BTL Listed to Revision 14 or later. Use of non-BTL Listed drives are not acceptable.
5. The drive shall be classified as an Applications Specific Controller (B-ASC). The interface shall support all BIBBs defined by the BACnet standard profile for a B-ASC including, but not limited to:
   a. Data Sharing: Read Property Multiple-B, Write Property Multiple-B, COV-B
   b. Device Management: Time Synchronization-B
   c. Object Type Support: MSV, Loop
6. 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.

J. Options (see schedule on drawings where applies):

1. Disconnect – A circuit breaker or disconnect switch shall be provided when indicated on the drive schedule. The disconnect shall be door interlocked and padlockable. Drive input fusing 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.

PART 3 - EXECUTION

3.1 EXECUTION

A. Sizing:

1. The drives shall be sized as required by the scheduled motors. See Mechanical and the Mechanical Drawing Schedules for motor information.

2. The drives shall be sized to continually operate the motors at continuously at the full rated horsepower at conditions scheduled on the drawings.
3. Either a variable or constant torque drive shall be selected based on the application and shall be provided as specified for each application.

B. Installation and Field Wiring:
1. Mounting and power wiring and power terminations shall be provided by Division 26.
2. Control wiring and control terminations shall be provided by Section 23 09 23.
3. The variable frequency drives on air distribution equipment shall be installed out of the airstream so that setup and testing can be accomplished without disrupting system pressures and airflows. In some applications where is not practical, such as packaged equipment, the drives shall be furnished with a remote mounting keypad which shall be installed in the controls section of the cabinet or other suitable enclosure on the side of the unit.

C. Field Start Up and Testing
1. The start-up and testing is to be provided at the installation site by the manufacturer or other agent deemed acceptable by the Owner's Representative.
2. Verify all installation connections and controls.
3. Field adjust all safety controls.
   a. For all drives with thermal overload protection, set and adjust drive program to thermally protect motor from overload conditions.
   b. Check fuses for proper thermal protection of drive.
4. Field adjust all drive parameters (including acceleration and deceleration ramps and volts-to-hertz ratio for smooth operation).
5. For all drives with remote disconnect, confirm that local disconnect has an auxiliary switch and that the switch is wired to the drive to interrupt the drive when local disconnect is used to de-energize equipment. Interconnecting wiring provided by Division 26.
6. All mechanical components shall be adjusted for proper alignment.
7. Demonstrate satisfactory operation of drive including line reactors, filters, under full load rpm.
8. Submit start-up and test report in accordance with Section 23 05 00.

D. Training
1. Provide in accordance with Section 23 05 00.
2. Provide on-site operation and maintenance training by manufacturer or other agent deemed acceptable by the Owner's Representative.

END OF SECTION

SECTION 23 21 13

HYDRONIC PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Access Doors

B. Cleaning of Piping Systems, System Cleaner

C. Heating Water, Equipment Drain and Overflow Piping, Above Grade

D. Unions, Flanges and Couplings

1.2 RELATED SECTIONS

A. Division 3 – Concrete

B. Division 8 – Access Doors

C. Division 9 – Painting

D. Section 23 05 00 – Common Work Results for HVAC

E. Section 23 05 17 – Sleeves and Sleeve Seals for HVAC

F. Section 23 05 19 – Meters and Gauges for HVAC Piping

G. Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment

H. Section 23 05 48 – Vibration Isolation

I. Section 23 05 53 – Identification for HVAC Piping and Equipment

J. Section 23 07 00 – HVAC Insulation

K. Section 23 09 23 – Direct-Digital Control for HVAC

L. Section 23 21 16 – Hydronic Piping Specialties

M. Section 23 25 00 – HVAC Water Treatment

1.3 REFERENCES

A. General

1. ASME - Boiler and Pressure Vessel Codes, SEC 9 - Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators
2. ASME B16.3 - Malleable Iron Threaded Fittings Class 150 and 300
3. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings
4. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
5. ASME B31.9 - Building Services Piping
6. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless
7. ASTM A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
8. ASTM B32 - Solder Metal
9. AWS D1.1 - Structural Welding Code

1.4 GENERAL

A. All materials shall be compatible with ethylene and propylene glycol.

1.5 SUBMITTALS FOR REVIEW (REFER TO SECTION 23 05 00)

A. Product Data: Include data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.

B. Product Data: Provide chemical treatment materials, chemicals, and equipment including electrical characteristics and connection requirements.

C. Cleaning and flushing plan.

1.6 QUALITY ASSURANCE

A. Welding Materials and Procedures: Conform to ASME SEC IX and applicable state regulations.

B. Welders Certification: In accordance with ASME SEC IX.

1.7 PROJECT RECORD DOCUMENTS (REFER TO SECTION 23 05 00)

A. Record actual locations of piping.

1.8 QUALIFICATIONS

A. Welders: Certified in accordance with ASME SEC 9 and AWS D1.1.

1.9 REGULATORY REQUIREMENTS

A. Conform to ASME B31.9 code for installation of piping system.

B. Welding Materials and Procedures: Conform to ASME SEC 9 and applicable state and local labor regulations.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 23 05 00.

B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.11 TESTING (REFER TO SECTION 23 05 00)

A. Test in the presence of the Owner's Representative.

B. Systems:
1. Heating Water

C. Above Grade Piping Test
1. Piping systems shall be tested with a hydrostatic test of not less than 125 psig. Due care shall be taken that equipment with a maximum working pressure which is less than the required test is removed from the line during the test. After the test is complete, the equipment shall be reinstalled and a test of the maximum working pressure of the equipment put on the connections to the respective equipment.
2. Test piping prior to insulating.

D. Submit certificate of tests to the Owner's Representative for review.

E. Include certificate of tests in the Operation and Maintenance manual.

PART 2 - PRODUCTS

2.1 ACCESS DOORS

A. Materials shall be in accordance with Division 8.

2.2 SYSTEM CLEANER

A. Materials
1. System Cleaner Manufacturers (Refer to Section 23 05 00):
a. Flint Services Inc., Product DetSol CW-LF
b. King Soft Water CW 425N
c. Nalco/Ecolab

2. A phosphate wetting agent combined with an alkaline surfactant with a sodium carbonate type alkalinity supplement introduced as necessary to produce 600 ppm of phenolphthalein alkalinity. Chemicals shall be non-toxic.

2.3 EQUIPMENT DRAIN AND OVERFLOW DRAIN (ABOVE GRADE)

A. Provide in accordance with Section 22 10 00.

2.4 HEATING WATER, CHILLED WATER, SNOW MELT HEATING WATER, HEAT RECOVERY WATER, CONDENSER WATER, EQUIPMENT DRAIN AND OVERFLOW PIPING (ABOVE GRADE)

A. Up to 2 inches:
1. Copper tubing: ASTM B88; type L; hard drawn
2. Fittings: solder wrought copper fittings, ASME B16.22; ASTM B32, 95-5 tin-antimony or tin and silver solder with melting range of 430 to 535 °F, lead-free. Fittings shall be full nominal diameter inside and long radius.
3. Steel: ASTM A53; schedule 40 black; ASME B16.3 malleable iron fittings; 125 psi; threaded joints

B. 2 inches and above:
1. Copper tubing: ASTM B88; type L; hard drawn
2. Fittings: ASME B16.22; ASTM B32, AWS A5.8, BCuP silver braze, lead-free. Fittings shall be full nominal diameter inside and long radius.
3. Steel: ASTM A53; schedule 40 black; ASME B16.3 malleable iron fittings; 125 psi; threaded joints

2.5 PIPE HANGERS AND SUPPORTS

A. Materials shall in accordance with Section 23 05 29.

2.6 UNIONS, FLANGES, AND COUPLINGS

A. Unions for Pipe 2 inches and under: 150 psig threaded malleable for ferrous piping; bronze with soldered joints for copper pipe.

B. Dielectric Connections: Union with galvanized or plated steel threaded end; copper solder end; water impervious isolation barrier.

PART 3 - EXECUTION

3.1 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

E. After completion, fill, clean, and treat systems. Refer to Section 23 25 00.

F. Provide temporary piping connections for use in cleaning and flushing provided in Section 23 25 00.

3.2 INSTALLATION – GENERAL

A. Provide pipe as indicated on the drawings.

B. Install in accordance with manufacturer's instructions and ASME B31.9.

C. Piping within the equipment room shall be vibration isolated in accordance with Section 23 05 48.

D. If the Contractor elects to utilize copper piping for the hydronic system, piping below 2" shall be soldered, and the 2" piping shall be brazed.

E. Route piping in orderly manner, parallel to building structure, and maintain gradient.

F. Provide piping and all required offsets and fittings in order to coordinate with other trades, minimize structural inferences, conserve space, and maintain headroom. Refer to Section 23 05 00 – Common Work Results for HVAC, paragraph Locations.

G. Group piping whenever practical at common elevations.

H. Sleeve pipe passing through partitions, walls and floors. (Refer to Section 23 05 17)

I. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 23 05 16.

J. Provide supports, hangers (and spacing), insulation, shields, sleeves, escutcheons, and inserts in accordance with Section 23 05 29.

K. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 23 07 00.

L. Provide access doors where fittings are not exposed unless indicated to be provided under other divisions. Access doors shall comply with Division 8.

M. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.

N. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.

O. Prepare unfinished supports and devices for finish painting in accordance with Section 23 05 53.

P. Install control valves, sensor wells, flow meters, and any other hydronic devices provided under Section 23 09 23 in accordance with the manufacturer's recommendations. Provide piping to hydronic differential pressure sensors provided under Section 23 09 23. Control devices are sized in Section 23 09 23. Provide adaptors from valve size to pipe size in the piping immediately at the valve connection points.

Q. Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

R. Flanges / Unions:
1. Steel Pipe:
   a. Threaded pipe, 2 inches smaller: Install unions downstream of each valve with screwed joint upstream
   b. Welded pipe, 2 ½ inches and larger: Flanged connections both sides of valve
   c. Use unions at final connection to each piece of equipment or apparatus having a threaded pipe connection.
   d. Use flanges at final connection to each piece of equipment or apparatus having a flanged pipe connection.
2. Copper Pipe:
   a. Threaded pipe: Install union down stream of each valve with screwed joint up stream. Use brass male adapters each side of valve.
   b. Soldered pipe: No unions required either side of valve.
   c. Use unions at final connection to each piece of equipment or apparatus having a threaded pipe connection.
   d. Use flanges at final connection to each piece of equipment or apparatus having a flanged pipe connection.
3. Notes to above: Temperature control valves shall have unions and/or flanges at each port. Valves with screwed connections that cannot be rotated shall have unions on each side of valve. Do not use direct welded or threaded connections to valves, equipment or other apparatus.

S. Use non-conducting dielectric connections whenever jointing dissimilar metals.

3.3 CLEANING OF PIPING SYSTEMS

A. Systems shall be operational, filled, hydrostatically tested, started, and vented prior to cleaning. Use water meter to record capacity in each system. Record capacity and include in Operation and Maintenance Manuals.

3.4 PREPARATION

A. Prior to water treatment being performed for closed loop systems the Division 23 and Section 23 09 23 contractors shall provide documentation that all control valves are connected and in operation and verify that all valves are in the open position for

complete circulation of cleaning chemical. Performing a cleaning procedure with closed valves may result in contamination of system.

B. Systems shall be operational, filled, hydrostatically tested, started, and vented prior to cleaning. Use water meter to record capacity in each system. Record capacity and include in Operation and Maintenance Manuals.

C. Mechanical Contractor shall make temporary piping connections, contractor providing work in this section shall furnish temporary pumps, and temporary bypass filter as required to properly accomplish all cleaning operations.

D. Place all manual and control valves serving main coil banks and terminal control units in open position during cleaning so that circulation through the mains and the runouts is obtained during cleaning.

E. Initially flush the system with cold water through temporary flushing and drain connection. Flushing shall be sufficient to remove all contaminants, such as cuttings, filings, lubricants, rust, scale, grease, solder, flux, welding residue and debris.

F. Verify that electric power is available and of the correct characteristics.

3.5 CLEANING AND FLUSHING WORK PLAN

A. The mechanical contractor shall develop a project specific work plan for cleaning and flushing. The treatment plan shall be coordinated with the piping contractor prior to submission to the Owner's representative.

B. Work plan shall be submittal with cleaning and flushing products. Submittals that do not include a treatment plan will be rejected and returned to the contractor without review.

C. The work plan shall include:
1. Flushing schedule and drawings or diagrams that will be used for inspection and sign off prior to and after procedure, at Owner's option.
2. Duration of flushing for each pipe system type
3. Repeat flushing (if required to due to phasing).
4. Specific procedures used for cleaning and flushing.
5. Flushing velocities and flow rates with calculations, drawings and diagrams showing sectioning or zoning of piping systems to achieve required velocities, locations and means of temporary bypasses and returns.
6. Temporary piping connections, temporary pumps and temporary bypass filters. Temporary pump motor size and power source.
7. Cleaning treatment products
8. Post treatment chemicals

D. Provide the CX agent and chemical treatment contractor in Section 23 25 00 with minimum two weeks notice in advance of each cleaning and flushing activity. Schedule activities during normal business hours as much as practical.

3.6 CLEANING SEQUENCE

A. Piping Systems Requiring Cleaning
   1. All hydronic heating piping systems require cleaning.

B. Documentation and Notification
   1. The contractor is to submit a list showing what chemicals are to be used and in what concentrations (MUST include data and instruction sheets on each chemical and their MSDS forms) for each system to be cleaned and treated, a minimum of two weeks prior to cleaning. 24 hours prior to cleaning, the Owner needs to be notified of the start of the cleaning process and its duration. Documented process and test results with certificates stating the date, time, system cleaned and treated and testing results.

C. Final Acceptance
   1. The cleaning and flushing must be complete, as well as Testing, Adjusting, and Balancing. If the balancer finds dirt, sludge, oil, cuttings, fittings, rust, scale or other such debris, the affected system is re-cleaned.
   2. Water quality report shall be provided to the Owner's Representative upon completion of cleaning.

D. Concentration for cleaning chemicals:
   1. 1 pound per 100 gallons of water for heating hot water systems.

E. Hot Water Heating Systems:
   1. Completely fill the system with cleaning solution and circulate throughout the system to assure a rapid, efficient clean-up of all suspended solids and foreign material present in the system.
   2. Apply heat while circulating, slowly raising temperature to 160 °F and maintain for twelve (12) hours minimum.
   3. Remove heat and circulate to 100 °F or less; drain systems as quickly as possible and refill with clean water.
   4. Circulate for 6 hours at design temperatures, then completely drain the system.
   5. Refill with clean water and flush via the flushing and draining connections for a minimum one (1) hour duration.
   6. Maintaining a full system and continuing the fresh water flush, operate the circulating pump, partially close and reopen all manual valve several times, operate all automatic control valves through several cycles and continue this operation until no further traces of cleaning compound are detected and until there is no evidence of particulate matter in the system.
   7. Drain the system. Clean all strainers. After cleaning strainers and removal of start-up strainers, refill the system with clean water, circulate for thirty (30) minutes and drain system. Following the final flushing operation, fill the piping with fresh water.
   8. Valve off coils, remove strainer for cleaning. Open supply isolation valve and drain until clear, then close supply valve. Open return isolation valve and drain until clear, then close return valve. Replace strainer and open isolation valves.

F. Boilers
   1. Boilers shall be boiled out prior to flushing piping systems in accordance with the boiler manufacturer's requirements using a formula consisting of an alkalinity supplement, dispersants and a phosphate compound such as Tri-Sodium Phosphate. This solution shall be introduced into the system at a rate sufficient to

procure phonolpthalein alkalinity test result of 600 PPM. The solution should then be circulated for a minimum of four hours duration and should be thoroughly drained and flushed. See boiler specifications for additional requirements.

G. Use neutralizer agents on recommendation of system cleaner supplier and approval of Architect/Engineer or Owner.

H. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

I. Close coordination with Section 23 25 00 is required. Section 23 25 00 will add specified treatment chemicals as soon as possible after cleaning and flushing. Treatment chemicals must be added within two (2) hours of filling system with clean water. Failure to add chemicals within the specified period will require that the system cleaning and flushing be performed again.

J. The cleaning firm shall, upon completion of cleaning and chemical treatment addition, tag each system so that tag is plainly visible as follows: “THIS SYSTEM HAS BEEN CHEMICALLY CLEANED AND TREATED”. Each strainer shall additionally be tagged indicating strainer has been cleaned and date of cleaning.

3.7 SUPPLEMENTAL REQUIREMENTS

A. At project closeout, installer shall be represented at final observation meeting by qualified personnel with equipment and two (2) copies of start-up reports.
   1. Owner’s Representative may choose and direct spot checking of system cleaning via strainer removal & blow-down. Systems not observed to be cleaned shall be re-drained, cleaned and flushed with appropriate chemicals re-introduced into system. This shall occur at no additional cost to the Owner.

END OF SECTION

SECTION 23 21 16

HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Air separators

B. Air vents

C. Balancing cocks

D. Coil piping packages

E. Expansion tanks

F. Flow control balancing valves (automatic)

G. Flow control balancing valves (manual)

H. Relief valves

I. Strainers

J. Venturis

1.2 RELATED SECTIONS

A. Section 22 05 04 – Plumbing Specialties

B. Section 23 05 00 – Common Work Results for HVAC

C. Section 23 05 23 – General Duty Valves for HVAC Piping

D. Section 23 21 13 – Hydronic Piping

E. Section 23 25 00 – HVAC Water Treatment

1.3 REFERENCES

A. ASME - Boilers and Pressure Vessel Codes, SEC 8-D-Rules for Construction of Pressure Vessels

1.4 SUBMITTALS FOR REVIEW (REFER TO SECTION 23 05 00)

A. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description, model and dimensions.

B. Furnish a manufacturer's data report for Pressure Vessels, Form U-1 as required by ASME Boiler Pressure Vessel Code for each compression and expansion tanks.

C. Submit Selections and sizing for all flow balancing valves (automatic or manual).

1.5 PROJECT RECORD DOCUMENTS (REFER TO SECTION 23 05 00)

A. Record actual locations of equipment and devices furnished under this section.

1.6 OPERATION AND MAINTENANCE DATA (REFER TO SECTION 23 05 00)

A. Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.7 DELIVERY, STORAGE, AND HANDLING (REFER TO SECTION 23 05 00)

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary protective coating on cast iron and steel valves.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 - PRODUCTS

2.1 AIR SEPARATORS

A. Manufacturers (Refer to Section 23 05 00):
1. Spirotherm
2. Taco
3. Wessels Wess
4. Armstrong

B. Construction and design:
1. In-line design, 150 psi working pressure
2. ASME SEC 8-D construction
3. Brass construction for sizes 1½ inches and smaller
4. Steel construction for sizes 2 inches and larger

5. Turbulence suppressive type air eliminator to separate micro bubbles and to remove stationary air pockets through absorption
6. Copper or stainless steel coalescing medium
7. Integral brass venting mechanism at top of unit
8. Side valve to remove floating liquids and debris from the surface
9. Threaded blowdown connection port at bottom
10. Sized for maximum water velocity of 4 fps and maximum pressure drop of 1.5 feet WG.

2.2 AIR VENTS

A. Manufacturers (Refer to Section 23 05 00):
   1. Bell and Gosset
   2. Hoffman
   3. Spirotherm
   4. Taco
   5. Caleffi
   6. Nexus

B. Manual Type:
   1. Basis of Design: Bell and Gossett, No. 4V
   2. 1/8 inch coin or screwdriver operated, brass connection

C. Automatic Type:
   1. Basis of design: Bell and Gossett, No. 87
   2. Brass or semi-steel body, copper float, stainless steel valve and valve seat; suitable for system operating temperature and pressure (150 psi at 240 °F minimum); with isolating valve
   3. Air vent shall be tapped for 1/8 inch IPS.

D. Automatic Type: High Capacity
   1. Basis of design: Bell and Gossett, No. 107A
   2. Non-modulating high capacity air vent design to purge free air from the system and provide positive shutoff at pressures up to 150 psig at a maximum temperature of 250 °F. The design of the high capacity air vent shall prevent air from entering the system if system pressure should drop below atmospheric pressure. The high capacity air vent shall be pilot operated for intermittent purging of free air at pressures up to 2 psig during normal system operation, and diaphragm operated for full capacity purging of free air at pressures between 2 to 150 psig.

E. Manual Type: High Capacity
   1. Short vertical sections of 2 inches diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber

2.3 BALANCING COCKS

A. Balancing cocks where indicated shall be ball or butterfly valves as specified in Section 23 05 23.

2.4 COIL PIPING PACKAGES

A. Manufacturers (Refer to Section 23 05 00):
   1. As listed under flow balancing valve sections (for manual or automatic flow balancing valves).

B. Automatic or manual flow control valves as specified in this section; flow control valves shall be complete with ball valve, flow control, two pressure/temperature test ports.

C. Combination strainer and ball valve shall be complete with blow-down strainer, one pressure/temperature test port and ground joint union for field exchange of internal components. Unit shall be all brass and stainless steel.

D. Valves and strainers shall be marked externally with size, capacity and direction of flow.

E. Hoses
   1. All hoses shall be equipped with swivel end connections at terminal unit. All end connections shall be crimped to meet stated pressure ratings. Serrated/slip fit connections are not acceptable.
   2. Flame Retardant Hoses. Hose materials shall be stainless steel braided over an EPDM liner. Hoses shall meet or exceed the ASTM-D380-83 standard and withstand working pressures of 1/2", 3/4": 300 PSI, 1”-1-1/4”: 250 PSI, 1-1/2": 210 PSI, 2”: 188 PSI, @ 200°F; Burst Pressure: 1/2": 1500 PSI, 3/4": 1200 PSI, 1”, 900 PSI, 1-1/4”: 750 PSI, 1-1/2” – 2”: 500 PSI.
   3. Hoses shall meet or exceed flame retardant testing per standards UL #723, NEPA #225, ANSI 2.5, UBC 42-1, and ASTM-E84A. after ten minutes and produce less than 5% smoke as compared to Red Oak flooring (100%)

2.5 EXPANSION TANKS

A. Manufacturers: (Refer to Section 23 05 00):
   1. Amtrol
   2. Armstrong
   3. Bell and Gossett
   4. Taco
   5. Wessels

B. Construction:
   1. Bladder Type: Welded steel; tested and stamped in accordance with ASME SEC 8-Div. 1; cleaned; prime coated; fitted with lifting rings and steel support saddle; tappings for installation of accessories; supplied with National Board Form U-1; 125 psi pressure rating; field-replaceable heavy duty butyl rubber bladder; air charging valve (standard tire valve); tank drain
   2. Tank shall be full or partial acceptance as scheduled.

C. Accessories:
   1. Manual air vent
   2. Pressure relief valve: Select for pressures noted on the drawings.
   3. Water pressure gauge: Install at system connection.
   4. Air pressure gauge: charging valve indicated above shall be independent of gauge, and shall be accessible without removal of gauge.

2.6 FLOW BALANCING VALVES (AUTOMATIC)

A. Manufacturers (Refer to Section 23 05 00):
   1. IMI Flow Design/Autoflow
   2. Griswold
   3. Nexus

B. Basis of Design: Autoflow Series YR

C. General: Pressure compensating; factory set to control within 5 % of selected rating at pressure differential of ten (10) times the minimum required full flow conditions. Valves shall be complete with flow control, two pressure/temperature test ports and ground joint union to allow field exchange of internal components without removing from pipeline. Unit shall be all brass and stainless steel.

D. Valves shall be marked externally with size, capacity and direction of flow.

2.7 FLOW CONTROL BALANCING VALVES (MANUAL) – “CIRCUIT SETTERS”

A. Manufacturers (Refer to Section 23 05 00):
   1. Armstrong
   2. Bell and Gossett
   3. Nibco
   4. Taco
   5. Nexus

B. General: Precision machined orifice with memory stop; calibrated external name plate and direction arrow. Flow control balancing valves shall have tight shut-off and 2 meter taps, each with internal check valve and thread protector. Component construction and materials shall be suitable for application.

C. Valves Serving Design Flows of Greater than 30 gpm: Valve adjustment shall occur over a minimum of 720° adjustment rotation.

D. Circuit Setters shall be sized for a minimum of 2 foot water pressure drop and a maximum of 5 foot drop at design flow rate.

E. Connections:
   1. Up to 2 inches: Threaded or sweat
   2. 2½ inches and larger: Flanged

F. Flow control balancing valves shall be sized based on scheduled equipment flow rate according to the manufacturer’s guidelines.

2.8 SAFETY RELIEF VALVES

A. Manufacturers (Refer to Section 23 05 00):
   1. Bell and Gossett
   2. Taco

B. Basis of Design:
   1. Bell and Gossett Series 790 and 1170

C. Construction:
   1. Body: Brass
   2. Diaphragm and Seat: EPDM
   3. Internal Wetted Parts: Brass
   4. ASME labeled, diaphragm assisted
   5. Maximum Working pressure 125 psig
   6. Maximum operating temperature 250 F
   7. Relief setting: As indicated on drawings

2.9 STRAINERS

A. Manufacturers (Refer to Section 23 05 00):
   1. Sarco
   2. Strong, Dunham Busch
   3. Webster
   4. Watson McDaniel
   5. Nexus

B. Size 2 inch and under:
   1. Basis of Design: Sarco IT, BT
   2. Screwed brass or iron body for 250 psig working pressure Y pattern with 1/32 inch stainless steel perforated screen
   3. Accessories: ¾ inch blow-off valve and cap

2.10 VENTURIS

A. Manufacturers (Refer to Section 23 05 00):
   1. Barco
   2. Hyspan
   3. HCI
   4. Nexus
   5. Griswold

B. Precision machined orifice with tag indicating size and flow ratings. Fittings shall have two meter taps, each with shut-off cock and thread protector.

C. Provide venturi with equal flow measuring capability to basis of design (scheduled) venturi. Venturis submitted without beta ratio information or flow measuring graphical information will be rejected.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Provide specialties in accordance with manufacturer's instructions and as indicated on the drawings.
2. Where large air quantities can accumulate, provide enlarged air collection standpipes.
3. Provide access doors where specialties are not exposed unless indicated to be provided under other divisions. Access doors shall comply with Division 8. Coordinate size and location with access requirements.

B. Air Separators:
1. Provide air separator on suction side of system circulation pump.

C. Air Vents:

1. Provide automatic air vents at high points in mechanical rooms, at coils in mechanical rooms, and where indicated on the drawings. Provide isolation ball valve at each vent for future service of vent.
2. Provide manual air vents other at system high points and as indicated.
3. Provide high-capacity air vent at the air separator, as specified with the air separator, and pipe to overflow tank.
4. Provide threaded ½ inch ball valve between high capacity and automatic air vents and line served. Pipe connection to be ½ inch minimum.
5. Provide manual air vents on all water coils and at high points of piping systems. All air vents shall have a manual shutoff.

D. Flow Control Balancing Valves:
1. Provide flow control balancing valves at all water coils, pumps, re-circ pump, pipe mains and equipment as indicated.
   a. Install flow control balancing valves with meter connections upward.
2. Valves shall be sized as noted in Part 2 Products. Provide concentric reducers on either side of valve when valve is smaller than line size.

E. Relief Valves:
1. Provide relief valves on pressure tanks, low pressure side of reducing valves, heat exchangers, and expansion tanks.
2. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.
3. Install relief valves without a vertical lift on the outlet piping.
4. Pipe relief valve outlet to nearest floor drain for water systems or empty overflow tank for glycol systems.
5. Where location of glycol feeder will not allow relief piping to be installed without a vertical lift, provide a chemical drum adjacent to relief valve and pipe relief valve to the drum.
6. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas. Connections from the outlet to the manifold piping shall enter the manifold at an angle no greater than 45 degrees to the direction of flow.

F. Strainers:
1. Provide ¾ inch valved drain and hose connection on strainer blow down connection.
2. Provide strainer upstream of all control valves, coils, reducing valves, traps and other devices with orifices.

G. Venturis:
1. Install venturi flow devices with required straight lengths of piping upstream and downstream of valve according to the manufacturer's recommendations.

END OF SECTION

SECTION 23 21 23

HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. In-Line Circulating Pumps

1.2 RELATED SECTIONS

A. Division 3 – Cast-in-Place Concrete

B. Section 23 05 00 – Common Work Results for HVAC

C. Section 23 05 13 – Common Motor Requirements for HVAC Equipment

D. Section 23 05 19 – Meters and Gauges for HVAC Piping

E. Section 23 05 23 – General Duty Valves for HVAC Piping

F. Section 23 05 48 – Vibration Isolation

G. Section 23 05 93 – Testing, Adjusting, and Balancing

H. Section 23 07 00 – HVAC Insulation

I. Section 23 09 95 – Variable Frequency Drives

J. Section 23 21 13 – Hydronic Piping

K. Section 23 21 16 – Hydronic Piping Specialties

L. Section 23 25 00 – HVAC Water Treatment

1.3 REFERENCES

A. General
1. UL 778 - Motor Operated Water Pumps
2. NFPA 70 - National Electrical Code

1.4 SUBMITTALS (REFER TO SECTION 23 05 00)

A. General
1. Construction: Verify each component of the construction requirements of these specifications including casing, impeller, shaft, sleeve, ring, and seat materials.

Indicate maximum continuous operating temperature and working pressures. Address requirements for suction and discharge tappings.

2. Performance Information: Provide all information indicated in the equipment schedule for each pump as a minimum including shut-off head, efficiency, brake horsepower, motor horsepower, motor voltage, and motor phase. Impeller diameter shall also be indicated.
3. Pump Curves: Provide certified pump curves for each pump with design flow and pressure plotted. Curves shall be provided on a chart with flow on the x-axis and pressure on the y-axis. Brake horsepower lines shall also be indicated on the chart sufficient to determine the approximate brake horsepower at any given point on the curve. Include NPSH curve when applicable.
4. Accessories: Indicate all accessories to be provided with each pump.

B. In-Line Circulating Pumps: Indicate lubrication and sealing of ball bearings. Provide manufacturer's installation instructions, including hanging and support recommendations.

1.5 OPERATION AND MAINTENANCE DATA (REFER TO SECTION 23 05 00)

A. Include the following minimum information: All pump performance and pump curve information required for equipment submittals; installation instructions; assembly views; replacement parts; and lubrication instructions including lubrication points, type of lubrication to be provided, and frequency of lubrication.

1.6 REGULATORY REQUIREMENTS

A. Products Requiring Electrical Connection: Listed and classified by UL as suitable for the purpose specified and indicated.

B. Electrical connection points (lugs) shall be UL listed for use with both copper and aluminum wiring.

1.7 EFFICIENCY STANDARDS

A. Pumps that require a 15 % or greater increase in brake horsepower than the scheduled equipment to meet the design flow and pressure requirements will not be considered equal and will not be accepted.

1.8 EXTRA MATERIALS (REFER TO SECTION 23 05 00)

A. Provide one (1) spare set of mechanical seals for each pump.

1.9 DRAWING SCHEDULES

A. Refer to drawings for specific capacities, dimensions, accessories, and other requirements supplemental to these specifications.

PART 2 - PRODUCTS

2.1 CLOSE COUPLED VERTICAL INLINE PUMPS (SUSPENDED)

A. Manufacturer (Refer to Section 23 05 00)
   1. Armstrong
   2. Bell and Gossett
   3. Taco

B. Pump casing shall be cast iron, suitable for 175 psig working pressure at 140 degrees F. The casing shall be hydrostatically tested to 150% maximum working pressure.

C. The casing shall be radially split to allow removal of the rotating element without disturbing the pipe connections.

D. The casing suction and discharge connections shall be the same size and shall be provided with drilled and tapped seal vent and pressure gauge connections.

E. Pump impeller shall be bronze, fully enclosed type. Impeller shall be dynamically balanced.

F. A bronze shaft sleeve, extended the full length of the mechanical seal area, shall be provided.

G. Mechanical seal shall be single spring inside type with carbon against O-ring mounted NiResist faces. EPDM elastomer with stainless steel spring and hardware shall be provided. Seal vent line shall be factory installed and shall be piped from the seal area to the pump suction connection.

2.2 VFD CONTROLLED PUMPS

A. All VFD controlled pumps (see VFD schedules on drawings) shall be provided with shaft grounding rings. Shaft grounding rings shall be attached to ground, coordinate with Division 26.

PART 3 - EXECUTION

3.1 PREPARATION

A. Verify that electrical power is available and of the correct characteristics.

3.2 GENERAL

A. Provide pumps in accordance with manufacturer’s instructions and as indicated.

B. Coordinate with Division 26 to ensure pumps are installed with sealproof electrical cord with 24” service loop to facilitate maintenance.

C. Provide access space around pumps for service. Provide no less than minimum as recommended by manufacturer.

D. When pump connections are smaller than piping line-size, decrease from line size with long radius reducing elbows or reducers. Pipe-size reduction shall occur near the pump connection, with all valving associated with the pump being of piping line-size.

E. Support piping adjacent to pump such that no weight is carried on pump casings.

F. Provide air cock and drain connection on horizontal pump casings.

G. Lubricate pumps before start-up.

H. Provide single pressure gauge at each pump with isolation gauges to isolate total, suction and discharge pressures. See Section 23 05 19.

I. Pump shall be vibration isolated in accordance with Section 23 05 48.

3.3 CLOSE COUPLED VERTICAL INLINE PUMPS (SUSPENDED)

A. Provide line-size shut-off valve and strainer on pump inlet. Provide separate line-size shut-off valve on pump discharge.

B. Provide union on each side of pump if pump body does not have flanged connections.

C. Provide pump motor support with spring isolation hanger when pump motor is installed in horizontal position.

END OF SECTION

SECTION 23 23 00

REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Refrigerant

B. Refrigerant Piping

C. Manual Refrigerant Shut-off valve

D. Access doors

E. Piping supports and inserts

1.2 RELATED SECTIONS

A. Division 08 – Access Doors

B. Division 09 – Painting

C. Section 23 05 00 – Common Work Results for HVAC

D. Section 23 05 17 – Sleeves and Sleeve Seals for HVAC

E. Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment

F. Section 23 05 48 – Vibration Isolation

G. Section 23 07 00 – HVAC Insulation

H. Section 23 81 26 – Split System Air Conditioners

1.3 REFERENCES

A. General
1. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
2. ASTM B280 - Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
3. AWS A5.8 - Brazing Filler Metal
4. UL 429 - Electrically Operated Valves

B. Piping
1. ASME B31.5 - Refrigeration Piping
2. ASME B31.9 - Building Services Piping

1.4 SUBMITTALS FOR REVIEW (REFER TO SECTION 23 05 00)

A. Shop Drawings: Submit schematic layout of system, including pipe sizes, risers, valves, specialty devices, equipment and critical dimensions. Layout shall be reviewed and approved by the supplier of the respective equipment (air cooled condensing units and air handling units).

B. Product Data: Provide general assembly of specialties, including manufacturers catalogue information. Provide manufacturers catalog data including load capacity.

C. Design Data: Submit design data indicating pipe sizing.

D. Test Reports: Indicate results of leak test, acid test.

E. Manufacturer's Installation Instructions: Indicate support, connection requirements, and isolation for servicing.

1.5 PROJECT RECORD DOCUMENTS (REFER TO SECTION 23 05 00)

A. Record exact locations of equipment and refrigeration accessories on record drawings.

1.6 OPERATION AND MAINTENANCE DATA (REFER TO SECTION 23 05 00)

A. Maintenance Data: Include instructions for changing cartridges, assembly views, spare parts lists.

1.7 REGULATORY REQUIREMENTS

A. Conform to ASME B31.9 for installation of piping system.

B. Products Requiring Electrical Connection: Listed and classified by UL, as suitable for the purpose indicated.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 23 05 00.

B. Deliver and store piping and specialties in shipping containers with labeling in place.

C. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.

D. Dehydrate and charge components such as piping and receivers, seal prior to shipment, until connected into system.

PART 2 - PRODUCTS

2.1 GENERAL

A. All specialty devices shall be suitable for system operating pressures and temperatures.

2.2 REFRIGERANT PIPING

A. Copper Tubing:
   1. ASTM B280 and ANSI B9.1
   2. Nitrogenized type ACR hard drawn
      a. Rated for use for 700 psig maximum working pressure at 250 degrees F

B. Fittings: ASME B16.22 wrought copper, long radius elbows
   1. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy melting range 1,190 to 1,480 degrees F
   2. Traps: Standard one piece

2.3 REFRIGERANT

A. Refrigerant: ASHRAE 34. Type as specified for each type of equipment. Refer to the schedules for types of refrigerant.

2.4 MANUAL REFRIGERANT SHUT-OFF VALVE

A. Manufacturers (Refer to Section 23 05 00):
   1. ConBraCo (Apollo)
   2. Henry
   3. Mueller
   4. Superior
   5. Virginia

B. Ball valves designed for refrigeration service and full line size.

C. Valves shall have cap seals.

D. Valves with hand wheels are not acceptable.

E. Provide service valve on each liquid and suction line at compressor.

F. If service valves come as integral part of condensing unit, additional service valves shall not be required.

2.5 ACCESS DOORS

A. In accordance with Division 8.

2.6 PIPING SUPPORTS AND INSERTS

A. In accordance with Section 23 05 00.

2.7 REFRIGERANT PIPING FLEXIBLE CONNECTORS

A. Mason ULCPS or approved equal.

B. Stainless steel braided hose with copper female sweat ends, UL approved for refrigerant service for pressures, temperatures and refrigerant type.

PART 3 - EXECUTION

3.1 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION

A. Provide refrigeration piping and specialty devices required for a complete operating systems as required by the condensing unit and split system unit manufacturer.

B. Where isolation valves, driers, etc. are an integral piece of the equipment, additional shall not be required.

C. Install refrigeration specialties in accordance with manufacturer’s instructions.

D. Route piping in orderly manner, with plumbing parallel to building structure, and maintain gradient.

E. Install piping to conserve building space and not interfere with use of space.

F. Group piping whenever practical at common elevations and locations. Slope piping one (1) % in direction of oil return.

G. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

H. Pipe Hangers and Supports Inserts: Provide in accordance with Section 23 05 29.

I. Provide clearance for installation of insulation and access to valves and fittings.

J. Provide access doors for access to concealed valves and fittings. Access doors shall be in accordance with Division 8.

K. Prepare unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Division 9.

L. Insulate piping and equipment; refer to Section 23 07 00.

M. Follow ASHRAE 15 procedures for charging and purging of systems and for disposal of refrigerant.

N. Install flexible connectors at right angles to axial movement of compressor, parallel to crankshaft.

O. Anchor pipe near each flexible connector.

P. Slope suction lines down toward compressor 1 inch per 10 feet. Locate traps at vertical rises against flow in suction lines, if required by the manufacturer.

Q. Refrigeration system connections shall be copper to copper type properly cleaned and brazed. Use flux only where necessary.
   1. No soft solder connections will be allowed in system. If used, refrigerant piping will be rejected and will be required to be re-piped with new piping and brazed joints.

R. Braze valve, sight glass, and flexible connections.

S. Circulate dry nitrogen through tubes being brazed to eliminate formation of copper oxide during brazing operation.

T. Anchor pipe near each flexible connector.

U. Fully charge completed systems with refrigerant after testing.

V. Power and control wiring to devices furnished under this section shall be provided under this section in accordance with Division 26 requirements.

W. Provide isolation valves at indoor fan coils and outdoor heat pumps/condensing units.

3.3 FIELD QUALITY CONTROL

A. Make evacuation and leak tests in presence of Owner's representative after completing refrigeration piping systems. A positive pressure test will not suffice for the procedure outlined below.
   1. Draw vacuum on each entire system with vacuum pump to 200 microns using a vacuum gauge calibrated in microns. Do not use cooling compressor to evacuate system nor operate it while system is under high vacuum.
   2. Break vacuum with Freon to be used and re-establish vacuum test. Vacuum shall hold for twenty-four (24) hours at 200 microns without compressor running.
   3. Conduct tests at 70 °F ambient temperature or above.
   4. Do not run systems until above tests have been made and systems started up as specified. Inform Owner's Representative of status of systems at time of final inspection and schedule start-up testing if prevented by outdoor conditions before this time.

5. After testing, fully charge system with refrigerant and conduct test with Halide Leak Detector.

END OF SECTION

SECTION 23 25 00

HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Chemical feeder equipment

B. Chemical treatment

C. Equipment, valves, controls, and connections to systems

1.2 RELATED SECTIONS

A. Section 23 05 00 – Common Work Results for HVAC

B. Section 23 09 23 – Direct-Digital Control for HVAC

C. Section 23 21 13 – Hydronic Piping

D. Section 23 52 16 – Condensing Boilers

1.3 REFERENCES

A. NFPA 70 - National Electrical Code

1.4 SUBMITTALS

A. Submit under provisions of Section 23 05 00.

B. Shop Drawings: Indicate system schematic, equipment locations, controls schematics, electrical characteristics, and connection requirements.

C. Product Data: Provide chemical treatment materials, chemicals, and equipment including electrical characteristics and connection requirements.

D. Manufacturer's Field Reports (Refer to Section 23 05 00):
   1. Indicate start-up of treatment systems when completed and operating properly.
   2. Indicate analysis of system water after cleaning and after treatment.

1.5 PROJECT RECORD DOCUMENTS (REFER TO SECTION 23 05 00)

A. Record actual locations of equipment and piping, including sampling points and location of chemical injectors.

1.6 OPERATION AND MAINTENANCE DATA (REFER TO SECTION 23 05 00)

A. Operation and Maintenance Data: Include data on chemical feed pumps, and other equipment including spare parts lists, procedures, and treatment programs. Include step by step instructions on test procedures including target concentrations. Include the volume of each system.

1.7 QUALIFICATIONS

A. Manufacturers-Chemicals: Company specializing in manufacturing the products specified in this section with minimum five (5) years documented experience. Company shall have local representatives with State Certified Laboratories and full-time service personnel in the area of the job site.

B. Installer: Company specializing in performing the work of this section with minimum five (5) years documented experience and who is approved by manufacturer.

1.8 QUALITY ASSURANCE

A. Start-up, system check, water samples, analysis, cleaning, flushing, and testing shall be performed by a single water treatment company for undivided responsibility.

B. Company shall only utilize qualified personnel active in the field of water treatment who are factory trained or authorized.

C. Analysis, testing and reports shall be performed by a State Certified Lab.

1.9 REGULATORY REQUIREMENTS

A. Conform to applicable code for addition of non-potable chemicals to building mechanical systems, and to public sewage systems.

B. Products Requiring Electrical Connection: Listed and classified by UL as suitable for the purpose specified and indicated.

1.10 MAINTENANCE SERVICE

A. Furnish service and maintenance of treatment systems for one (1) year from Date of Substantial Completion.

B. Provide technical service visits to perform field inspections and make water analysis on site. Detail findings in writing on proper practices, chemical treating requirements, and corrective actions needed. Submit two copies of field service report to the Owner’s representative after each visit.

C. Schedule:
1. Closed loop systems; a minimum of four visits per year on a quarterly basis.

D. Provide laboratory and technical assistance services during this maintenance period.

E. Include training course for operating personnel, instructing them on installation, care, maintenance, testing, and operation of water treatment systems in accordance with Section 23 05 00. Arrange course to occur at start-up of systems.

F. Provide on-site inspections of equipment during scheduled or emergency shutdown to properly evaluate success of water treatment program and make recommendations in writing based upon these inspections.

1.11 MAINTENANCE MATERIALS

A. Provide maintenance materials under provisions of Section 23 05 00.

B. Provide sufficient chemicals for treatment and testing for one year from the date of substantial completion.

1.12 WORK PROVIDED IN OTHER SECTIONS

A. Cleaning and flushing and cleaning/flushing chemicals are provided in Section 23 21 13.

B. This contractor has responsibility of oversight that cleaning and flushing has been properly accomplished by drawing of samples of system. This contractor also has responsibility of adding chemicals immediately after cleaning and flushing has been completed (within 2 hours) to maintain water chemistry for equipment and pipe protection. Section 23 21 13 is required to provide contractor providing work in this section with minimum two week notice of system cleaning and flushing.

PART 2 - PRODUCTS

2.1 MANUFACTURERS/INSTALLERS (REFER TO SECTION 23 05 00):

A. Power Engineering

2.2 MATERIALS

A. Closed System Treatment Heating Hot Water:
   1. Manufacturers (Refer to Section 23 05 00):
      a. Flint Services Inc., Product CS-39
      b. King Soft Water: CST-N25
      c. Nalco
      d. Betz
      e. Power Engineering Co.: Product PECO 8410
   2. Chemical properties:
      a. Ferrous metal corrosion inhibitor product shall provide corrosion protection by the use of sodium molybdate, sodium nitrate, and sodium borate technique.

b. Non-ferrous metal corrosion inhibitor product shall provide corrosion protection by the use of tolytriazole.
c. System shall be treated with biocides to prohibit biological growth within the closed system.
d. Sequestering agent to reduce deposits and control PH.

2.3 TEST EQUIPMENT

A. Basic water test equipment shall be provided for determination of treatment residuals. This shall include a carrying case and reagents for use with the supplier's products. Where specialized or supplementary equipment is required, it shall be furnished as of the offering.

PART 3 - EXECUTION

3.1 PREINSTALLATION

A. Water treatment contractor shall draw samples to ensure cleaning and flushing has been completed and add chemicals within

3.2 INSTALLATION

A. Furnish and install all devices as specified in this section and indicate on the drawings in accordance with manufacturer's instructions.

B. All piping and wiring for chemical treatment shall be provided under this section unless indicated otherwise on the drawings.

C. Systems shall be complete and shall be installed in strict accordance with the manufacturer's diagrams and recommendations, including all piping and electrical work.

D. The manufacturer's representative shall be responsible for assisting the contractor during construction and shall charge the systems.

E. Solution tanks and solution metering pumps: Pump location shall be a maximum of 24 inches above the top of the chemical barrel to avoid excessive suction lift. Chemical shall be pumped direct from the shipping container.

3.3 CLOSED SYSTEM TREATMENT

A. There shall be no glycol in the heating water system.

END OF SECTION

SECTION 23 30 13

AIR HANDLING EQUIPMENT SOUND LEVELS

PART 1 - GENERAL

1.1 SECTION INCLUDES:

A. Air Handling Equipment Sound Levels

1.2 RELATED SECTIONS:

A. Section 23 73 00 – Central Station Air Handling Equipment

B. Air Handling Equipment

1.3 QUALITY ASSURANCE

A. All air-handling equipment listed below shall have been tested according to the following:
1. Air handling units to be tested in complete accordance with the latest revision of AMCA and AHRI. When operating at the maximum design capacities, the tested sound power values shall not exceed the values scheduled in the following table.

Table 1: Air Handling Unit Maximum Allowable Sound Power Values

Unit	Source	63	125	250	500	1K	2K	4K	8K
AHU-1	Inlet	80	79	87	79	74	73	68	65
AHU-1	Discharge	86	85	90	85	83	80	75	70
AHU-1	Radiated	51	62	71	73	74	67	61	52
MAU-1	Discharge	61	65	79	77	79	79	77	68
MAU-1	Condenser Fans	101	93	94	91	91	86	77	75
MAU-2	Discharge	65	70	79	78	82	80	82	77
MAU-2	Condenser Fans	70	87	85	90	88	94	78	73
ECU-1	Fan Inlet	79	82	86	87	83	79	72	64
ECU-2	Fan Inlet	79	82	86	87	83	79	72	64
ECU-3	Fan Inlet	79	79	91	82	82	77	69	63
ECU-4	Fan Inlet	70	73	77	79	76	72	64	57
EF-1A/B	Inlet	85	86	95	85	83	79	75	73
EF-1A/B	Radiated	88	87	91	79	75	64	57	57
EF-2	Inlet	85	86	91	84	81	78	75	71
EF-2	Radiated	88	87	89	78	73	63	57	55
EF-3	Inlet	79	86	78	82	71	65	64	62

Unit	Source	63	125	250	500	1K	2K	4K	8K
EF-3	Radiated	80	88	72	76	66	59	58	58
EF-4	Inlet	82	86	79	84	73	67	67	65
EF-4	Radiated	83	88	73	78	68	61	61	61

1.4 SUBMITTALS

A. Submit under provisions of Division 23.

B. All submittals shall include data indicating compliance with AMCA 300 and ARI 260 standards

END OF SECTION

SECTION 23 31 00

HVAC DUCTS AND CASINGS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. General Materials

B. Flexible ducts

C. Low velocity ductwork and fittings

D. Medium velocity ductwork and fittings

1.2 RELATED SECTIONS

A. Section 23 05 00 – Common Work Results for HVAC

B. Section 23 05 17 – Sleeves and Sleeve Seals for HVAC

C. Section 23 05 29 – Hangers and Supports for HVAC Piping and Fittings

D. Section 23 33 00 – Air Duct Accessories

E. Section 23 35 16 – Engine Exhaust Systems

F. Section 23 36 00 – Air Terminal Units

G. Section 23 37 00 – Air Outlets and Inlets

1.3 REFERENCES

A. ASTM A 36 - Structural Steel

B. ASTM A 90 - Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles

C. ASTM A 366 - Steel, Sheet, Carbon, Cold Rolled, Commercial Quality

D. ASTM A 525 - General Requirements for Steel Sheet, Zinc- Coated (Galvanized) by the Hot-Dip Process

E. ASTM A 527 - Steel Sheet, Zinc-Coated (Galvanized) by Hot-Dip Process, Lock Forming Quality

F. NFPA 90A - Installation of Air Conditioning and Ventilating systems

G. SMACNA - HVAC Air Duct Leakage Test Manual

H. SMACNA - HVAC Duct Construction Standards - Metal and Flexible

I. UL 181 - Factory-Made Air Ducts and Connectors

1.4 PERFORMANCE REQUIREMENTS

A. Drawings showing duct arrangements are diagrammatic only and do not attempt to show all offsets and fittings required. The contractor shall adjust the work as required to facilitate installation, COORDINATE WITH STRUCTURE AND OTHER TRADES. See Section 23 05 00, - “Locations”.

B. If changes of duct configuration or sizes are required to facilitate installation, obtain written permission from Owner’s Representative before proceeding with fabrication and installation.

1.5 SUBMITTALS FOR REVIEW (REFER TO SECTION 23 05 00)

A. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA HVAC Air Duct Leakage Test Manual. Furnish for O&M Manual.

B. Submit manufactured medium pressure ductwork and fittings.

C. Exposed ductwork:
1. Submit duct hanger plan for review and approval prior to fabrication and installation of exposed ductwork.

1.6 PROJECT RECORD DOCUMENTS (REFER TO SECTION 23 05 00)

A. Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.7 QUALITY ASSURANCE

A. Perform Work in accordance with SMACNA - HVAC Duct Construction Standards - Metal and Flexible. - Latest Edition.

B. Maintain one copy of document on site.

1.8 REGULATORY REQUIREMENTS

A. Construct ductwork to the International Mechanical Code, and SMACNA, HVAC Duct Construction Standards - Metal and Flexible, Latest Edition

B. Where more than one standard is referenced, the most restrictive shall apply.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.

B. Maintain temperatures during and after installation of duct sealants.

1.10 DELIVERY, STORAGE AND HANDLING:

A. Where possible, store products inside and protect from weather. Where necessary to store outside, store above grade and enclose with a vented waterproof wrapping.

B. Ductwork shall be protected and handled in accordance with SMACNA Intermediate Level of duct cleanliness for new construction. See Section 23 05 00 for additional requirements.

PART 2 - PRODUCTS

2.1 ENGINE EXHAUST SYSTEM DUCTWORK

A. Refer to Section 23 35 16 for all requirements pertaining to the engine exhaust ductwork and requirements.

2.2 GENERAL MATERIALS

A. Galvanized Steel Ducts: ASTM A525 and ASTM A527 galvanized steel sheet, lock-forming quality, having G60 zinc coating in conformance with ASTM A90.

B. Sealants for metal ductwork:
1. Sealant Class A, B and C: Hardcast, Duradyne, Ductmate, or approved equal.
2. Exterior Systems:
   a. Hardcast Inc. DT-Tape and RTA-50 adhesive two-part sealing system, or Hardcast Inc. Aluma-Grip 701 pressure sensitive rolled sealant tape.
3. Non-hardening, water resistant, fire resistive, compatible with mating materials.
4. Sealant shall be compositely tested for fire and smoke hazard ratings according to recognized standard testing methods (ASTM E84) and shall have ratings not exceeding flame spread 25, fuel contributed 50 and smoke developed 50.
5. Sealants used on all non-exterior ductwork shall be water based (no solvents)

C. Hanger Rod: ASTM A36; galvanized steel; threaded both ends, threaded one end, or continuously threaded.

2.3 FLEXIBLE DUCTS

A. Manufacturers (Refer to Section 23 05 00):
1. Genflex
2. Thermaflex

3. Thermold
4. Wiremold
5. Hart and Cooley

B. Basis of Design: Thermaflex, Model G-KM

C. UL 181 Class 1 flexible air duct complying with NFPA standard 90A; factory fabricated assembly composed of an inner liner, coated wound spring steel wire, 1 inch thick fiberglass insulation (installed R-value 4.3), and a vapor barrier outer jacket; 6 inches WG positive working pressure and 1 inch WG negative working pressure for ducts up to 10 inch diameter, 4 inches WG positive working pressure and 1 inch WG negative working pressure for ducts 12 to 16 inches diameter; 4000 FPM maximum working velocity; 20 to 200 °F working temperatures.

2.4 EXPOSED DUCTWORK

A. Exposed ductwork shall be as defined and constructed to the requirements of medium velocity exposed ductwork and fittings.

2.5 LOW VELOCITY DUCTWORK AND FITTINGS

A. Low velocity ductwork shall be defined as all ductwork not specifically defined as medium velocity ductwork.

B. Fabricate, install, and support in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, the International Mechanical Code, and as indicated. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.

C. Construct T's, bends, and elbows with radius of not less than 1½ times width of duct on centerline. Provide turning vanes in all rectangular elbows greater than 45 degrees (unless utilized for return duct stub-outs into return air plenums - no vanes required).

D. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.

E. Where flat oval or k27 ductwork is indicated on the floor plans, ductwork shall be as defined and constructed to the requirements of medium velocity ductwork and fittings.

F. Low velocity plenums
1. Plenums shall be at least two (2) gauges heavier than specified ductwork of equal size.
2. Provide access doors to service equipment. Fabricate with 16 gauge steel double wall construction with 1 inch thick fiberglass insulation in core. Openings shall be reinforced with welded angle bar frames. Doors shall be pulled airtight on neoprene gaskets.

2.6 MEDIUM VELOCITY DUCTWORK AND FITTINGS

A. Medium velocity ductwork shall be defined as all ductwork between the air handling equipment and the terminal supply, return, or exhaust boxes.

B. Fabricate, install, and support in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, the International Mechanical Code, and as indicated. Provide duct material, gauges, reinforcing, and sealing for operating pressures.

C. Round and Flat Oval Ductwork
1. Manufacturers (Refer to Section 23 05 00):
   a. United McGill Corp., Model Uni-Seal (un-lined)
   b. United McGill Corp., Model K-27 (lined with insulation)
   c. Ventline
   d. Metco
   e. Apollo Inc.
   f. L&R Fabrication
   g. SMK Inc.
2. Spiral lockseam construction (no standing ribs)
3. Fittings shall be all welded, or fully lapped and sealed spot welded, construction with machine formed entrances to branch fittings. All welding of fittings shall be of the continuous seam fusion type. All welded seams shall be covered with one coat of rust inhibiting paint, Rust-Oleum or approved equal, applied to both interior and exterior of duct or fittings.
4. Centerline radius of elbows shall be 1.5 times the cross section diameter unless the drawings indicate a mitered 90 degree elbow with vanes. Elbows shall be constructed with five pieces for turns greater than 60 degrees, three pieces for turns between 60 degrees and 30 degrees, and two (2) pieces for turns 30 degrees and less.
5. Round/Rectangular ducts:

Duct Size inches	**U.S. Duct Gauge**
Up to 8	26
9 to 14	26
15 to 26	24
27 to 36	22
37 to 50	20
Over 51	18

Fitting Size inches	**U.S. Duct Gauge**
Up to 26	22
27 to 50	20
52 to 60	18

6. Fittings shall be equal to United McGill Corp. as follows:
   a. Elbows: SRHE5-90, SRHE3-60, SRHE3-45, SRHE2-30
   b. Tees: SRHTC, SRHTCR, SRHTXC, SRHTXCR
   c. Laterals: SRHLC, SRHLCR
   d. Concentric reducer: SRHR

e. Eccentric reducer: SRHRE

7. Joints in ducts and fittings up to and including 36 inch in diameter shall be made with couplings (2 inch insertion depth with stophead). Larger ducts and fittings shall be joined with companion flanges. Couplings and flanges shall be supplied by the duct manufacturer.

D. Flat Oval Ducts:

Duct Size (Major axis) inches	**U.S. Duct Gauge**
Up to 24	24
25 to 48	22
49 to 60	20

Fitting Size inches	**U.S. Duct Gauge**
Up to 36	20
37 to 60	18

1. Fittings shall be equal to United McGill Corp. as follows:
   a. Elbows: SRSEH5-90, SOSEE5-90, SOSEH3-45, SOSEE3-45
   b. Tees: SOSTC, SOSTXC
   c. Laterals: SOSLC
   d. Concentric transition: SOSR-10, SOSR-30
   e. Eccentric transition: SOSR-11, SOSR-12, SOSR-131, SOSR-132, SOSR31, SOSR32, SOSR331, SOSR332
2. Joints in ducts and fittings up to and including 41 inches wide and 26 inches high shall be made with couplings. Larger ducts and fittings shall be joined with companion flanges. Couplings and flanges shall be supplied by the duct manufacturer.

E. Lined Round and Flat Oval Ducts:
1. Machine made from round or flat oval spiral lockseam duct, galvanized steel outer wall, 1 inch thick fiberglass insulation, perforated galvanized steel inner wall; fittings manufactured with solid inner wall.
2. Previous sections on round and flat oval ducts apply here.

F. Exposed Round and Oval Ductwork
1. Exposed Ductwork shall be defined as ductwork that is exposed to view in all areas, including the shop areas.
2. Spiral lockseam construction (spiral seam with no standing ribs)
3. Paintable galvanized steel shipped without oils and other residue to allow for field painting of ductwork.
4. Joints shall be fully lapped.
5. No spot welding shall be visible on fittings.
6. Centerline radius of elbows shall be 1.5 times the cross-section diameter unless the drawings indicate a mitered 90 degree elbow with vanes. Elbows shall be constructed with five pieces for turns greater than 60 degrees, three pieces for turns between 60 degrees and 30 degrees, and two (2) pieces for turns 30 degrees and less.
7. Ductwork shall have built in taps instead of separate fittings.

8. All spiral seams shall line up when installed.
9. Manufacturers Round Exposed Ductwork (refer to Section 23 05 00):
   a. United McGill Exposed Product Line with Uni-Rib spiral duct.
10. Round ducts:

Duct Size inches	U.S. Duct Gauge
Up to 8	26
9 to 14	26
15 to 26	24
27 to 36	22
37 to 50	20
Over 51	18

Fitting Size inches	U.S. Duct Gauge
Up to 26	22
27 to 50	20
52 to 60	18

11. Fittings for exposed ductwork shall be United McGill (or approved equal) Uni-Seam ribbed elbows to matched the appearance of the ribbed spiral duct.
12. Joints in ducts and fittings up to and including 36 inch in diameter shall be made with couplings (2 inch insertion depth with stophead).
13. Reinforcements shall line up with duct hangers.
14. Ductwork will not be painted so galvanized appearance is required to be uniform throughout without scratches.
15. Duct hangers for round duct shall attached to the structure with a single support. See details on drawings.

G. Exposed Rectanglar Ductwork
1. Exposed Ductwork shall be defined as ductwork that is exposed to view in all areas, including the shop areas.
2. Exposed ductwork shall abide with all medium pressure rectangular ductwork requirements.
3. Paintable galvanized steel shipped without oils and other residue to allow for field painting of ductwork.
4. No spot welding shall be visible on fittings.
5. Ductwork shall have built in taps instead of separate fittings.
6. Joints in ducts and fittings up to and including 36 inch in diameter shall be made with couplings (2 inch insertion depth with stophead).
7. Reinforcements shall line up with duct hangers.
8. Ductwork will not be painted so galvanized appearance is required to be uniform throughout without scratches.
9. Duct hangers for oval or rectangular duct shall be in accordance with SMACNA requirements.
10. Duct joints shall be internally sealed.

PART 3 - EXECUTION

3.1 INSTALLATION-GENERAL

A. Provide in accordance with manufacturer's instructions and as indicated on the drawings.

B. Install and seal ducts in accordance with International Energy Conservation Code and SMACNA HVAC Duct Construction Standards - Metal and Flexible and as specified for the specified pressure class and sealant class.

C. Duct Sizes are gross outside dimensions. Where ductwork is indicated on the drawings to be lined, an allowance for 1 inch insulation has been included and duct sizes to not need to be increased to compensate for the insulation. Note: Internally insulated ductwork incorporating 2 inches of internal lining has been utilized in selected locations as noted on the drawings (duct sizes do not need to be increased to compensate for the 2 inch insulation).

D. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

E. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

F. Use crimp joints with or without bead for joining round duct sizes 8 inches and smaller with crimp in direction of air flow.

G. Use double nuts and lock washers on threaded rod supports.

H. Flexible ducts not exceeding six (6) feet in length may be used to connect grilles and diffusers where ductwork is not exposed. Note: Refer to applicable details for GRD (grille, register, diffusers) connections. Flexible ductwork shall not be utilized to connect to grilles and diffusers where duct is exposed to view.

I. Low velocity plenums:
   1. Construct with angle iron framing suitably reinforced to prevent sagging, breathing or vibration. The building structure shall not be used as walls or ceilings or plenums unless specifically indicated. All portions of the plenums shall be ½ inch minimum clearance from building structure.
   2. Where plenums are indicated to be fastened to the building floor, plenum construction shall be angle iron frame bolted to the floor with caulking compound applied before tightening.
   3. When plenums are not indicated to be set on the floor, the bottom of the plenum shall have additional angle iron bracing than required by ducts of the same size. Connect air inlets and outlets to low pressure ducts with 5 feet maximum length of flexible duct held in place with strap or clamp.

J. Connect flexible ducts to metal ducts with duct sealer and secured over sheet metal collar with ½ inch wide positive locking strap. Flexible duct is not allowed on smoke control systems

K. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

L. Internal surfaces of the uninsulated ductwork shall be wiped to remove excess dust immediately prior to installation, in accordance with SMACNA Intermediate Level of duct cleanliness for new construction.

M. Paint ductwork visible through air inlets and outlets flat black.

N. Make required offsets and transitions in ductwork in accordance with Section 23 05 00 (“Locations”) and this section. Offsets shall be the least angle possible. Changes shall be submitted to the Owner’s representative in shop drawing form before proceeding with the work so that the effects of offsets on system performance can be evaluated.

3.2 EXPOSED DUCTWORK

A. Exposed Ductwork shall be defined as ductwork that is exposed to view in the public areas, as outlined above.

B. Exposed ductwork shall be constructed to the requirements of the Medium Velocity duct and fittings as described for exposed ductwork.

C. Ductwork shall be rigid (no flex ducts allowed at connections to grilles, registers and diffusers).

D. Prior to fabrication and installation of ductwork, prepare duct fabrication drawings in these areas with duct layout and support details. Submit to architect and engineer for review on site at a pre-installation conference.

E. Identify hanger supports in duct hanger plan submitted prior to fabrication, and provide support at even intervals that are logically coordinated with the structure, and in accordance with SMACNA requirements.

F. Prior to installation of all of the ductwork, mock-up ductwork in one room that is approved by the architect/engineer. After review and approval by the architect/engineer, proceed with the installation of remaining ductwork.

G. Sealants shall be applied to the inside surface of the duct when mating sections and any excess sealant wiped clean so not visible on the ductwork.

H. Exposed ductwork shall not be wrapped with exterior duct wrap.

3.3 INSTALLATION-MEDIUM VELOCITY DUCTWORK

A. Bullhead and straight tees will not be permitted.

3.4 CLEANING

A. Ducts which accumulate dust and debris during construction shall be cleaned by the Contractor at no expense to the Owner.
   1. Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment which may be harmed by excessive dirt with temporary filters, or bypass during cleaning.
   2. Ductwork which does not become clean by the above method shall be cleaned with high power vacuum machines. Protect equipment which may be harmed by excessive dirt with filters, or bypass during cleaning. Provide adequate access into ductwork for cleaning purposes.

3.5 SCHEDULES

A. Provide duct materials in accordance with schedule below.

B. Apply sealants to all ductwork in accordance with the schedule.

C. Ductwork Material and Pressure Class Schedule

Air System	**Pressure Class inches WG**	**Material**
Low Velocity	2 Positive or Negative	Galvanized Steel
Medium Velocity	6 Positive or Negative	Galvanized Steel

D. Sealants - Metal Ductwork
   1. Seal ductwork in accordance with table below.
   2. Openings for rotating shafts shall be sealed with bushings or other devices that seal off air leakage.
   3. Pressure sensitive tape is not an approved sealing method.
   4. All connections shall additionally be sealed, including but not limited to spin-ins, taps, other branch connections, access doors, access panels and duct connections to equipment.
   5. Sealants that would void the product listings is not required.
   6. Spiral lock seams need not be sealed except at transverse joints and fittings.
   7. Fittings and joints that are continuously welded ductwork do not require sealant.

Pressure Class inches WG	**Sealant Class**	**Description**
Up to 2	Class C	Seal all transverse joints and longitudinal seams with Class C sealant.
4 and Greater	Class A	Seal all transverse joints, longitudinal seams, and ductwall penetrations with Class A sealant.
Exterior Systems		Seal completely water tight. Paint entire system with an asphalt base aluminum paint.

3.6 FIELD QUALITY CONTROL

A. Testing (Refer to Section 23 05 00)
1. Duct systems constructed to pressure classes 3 inches (positive or negative) WG and under (low velocity) shall be tested as follows.
   a. Supply ductwork downstream of terminal boxes: Test a minimum of two representative terminal units and pressurize to 2 inches WG with a maximum allowable leakage of 3% of the terminal unit capacity measured by a calibrated orifice type flow meter. Additional testing of terminal box low pressure supply ductwork will not be required if visual inspection indicates sealing to level equivalent in quality to the representative test section.
   b. Other Systems: the low pressure supply ductwork, return air, relief air, exhaust air and outside air ductwork systems shall be sealed and leakage tested so that the leakage rate at the design pressure does not exceed 6 percent of the fan flow. Leakage rate shall be determined by field verification and diagnostic testing, in accordance with SMACNA Duct Leakage Test Procedures, current edition.
2. Provide leakage tests in accordance with the methods below for duct systems constructed to pressure classes greater than 3 inches (positive or negative) WG and all outdoor duct systems.. Allowed air leakage (CFM) shall be less than the values calculated by both of the two following methods:
   a. Method 1:
      1) Testing shall be in accordance with SMACNA HVAC Air Duct Leakage Test Manual and shown to have a rate of air leakage (CL) less than or equal to 4.0 as determined in accordance with the equation: $CL=F/P^{0.65}$, where:
         a) F = The measured leakage rate in cfm per 100 square feet of duct surface
         b) P = The static pressure of the test.
   b. Method 2:
      1) 3 % of the entire air handling capacity of the system.
   c. Provide documentation demonstrating that representative sections totaling at least 100% percent of the total duct area have been tested and that all tested sections meet the requirements of both leakage methods above.
   d. Minimum test pressure shall be 3.0 inches W.G.
   e. Air leakage shall be measured by a calibrated orifice type flow meter.
3. Outside air duct systems between the motorized control damper and the building exterior envelope shall be leak tested. Leakage shall not exceed 0.40 cfm/fts at a pressure of 0.3” water gauge and test results shall be submittal to the building official with the building envelope leakage test where such leakage tests are required.
4. Perform tests in the presence of the Owner’s Designated Representative. Owner’s Representative shall sign test reports as witness. When each system is complete, submit to the Owner’s representative for review and approval. Submit final reports for inclusion in O&M Manual.

END OF SECTION

SECTION 23 33 00

AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Air turning devices

B. Duct access doors

C. Duct test holes

D. Volume control dampers

E. Spin-in fittings

1.2 RELATED SECTIONS

A. Section 23 05 00 – Common Work Results for HVAC

B. Section 23 05 48 – Vibration Isolation

C. Section 23 05 49 – Seismic Controls for Mechanical

D. Section 23 09 23 – Direct-Digital Control for HVAC

E. Section 23 31 00 – HVAC Ducts and Casings

F. Section 23 36 00 – Air Terminal Units

1.3 REFERENCES

A. NFPA 90A - Installation of Air Conditioning and Ventilating Systems

B. SMACNA - HVAC Duct Construction Standards - Metal and Flexible

1.4 SUBMITTALS FOR REVIEW

A. Submit under provisions of Section 23 05 00. Include electrical characteristics and connection requirements.

B. Submit relieving performance information on pressure relief access doors with the submittals (airflow versus pressure).

1.5 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 23 05 00.

1.6 REGULATORY REQUIREMENTS

A. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories Inc., as suitable for the purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 23 05 00.

B. Protect dampers from damage to operating linkages and blades.

PART 2 - PRODUCTS

2.1 AIR TURNING DEVICES

A. Manufacturers (Refer to Section 23 05 00):
1. Duro Dyne
2. Aero/Dyne
3. Titus
4. Tuttle and Bailey
5. Krueger
6. Pottorff

B. Fabrication in accordance with SMACNA–HVAC Duct Construction Standard–Metal and Flexible suitable for duct pressure classification.

C. Multi-blade device with single vane blades aligned in short dimension; with individually adjustable blades, mounting straps, galvanized steel, stainless steel or aluminum to match ductwork.

D. Vanes installed in ductwork of unequal widths or angles shall have vanes shaped to project airflow parallel to duct sides.

E. Air turns in medium velocity ductwork shall be high efficiency, double vane blades equal to H-E-P as manufactured by Aero/Dyne constructed with 2 inches long airfoil leading edge and a 3 inches long airflow trailing edge.

2.2 DUCT ACCESS DOORS

A. Manufacturers (Refer to Section 23 05 00):
1. Elmdor
2. United McGill
3. Duro Dyne

4. Cesco
5. Pottorff
6. Ruskin

B. Fabricated in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.

C. Fabrication: Rigid and close-fitting of galvanized steel, stainless steel or aluminum to match ductwork with sealing gaskets, quick fastening locking devices, and continuous piano hinge. For insulated ductwork, install minimum 1 inch thick insulation with sheet metal cover.
1. Less than 12 inches square: Secure with sash locks
2. Up to 18 inches square: Secure with two sash locks
3. Up to 24×48 inches: Secure with two compression latches with outside and inside handles

D. Access doors with sheet metal screw fasteners are not acceptable.

2.3 DUCT TEST HOLES

A. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.4 VOLUME CONTROL DAMPERS

A. Manufacturers (Refer to Section 23 05 00):
1. Ruskin
2. Greenheck
3. Pottorff

B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.

C. Material: Galvanized steel, stainless steel or aluminum to match ductwork.

D. Single Blade Dampers:
1. Fabricate for duct sizes up to 12 inches high and 30 inches long. Dampers greater than 12 inches high shall be multi-blade.
2. Blades shall have 1/8 inch clearance all around and shall operate within duct liner.
3. Up to 18 inches long, 20 gauge with 3/8 inch rod pins and quadrant.
4. 19 to 48 inches long, 16 gauge with ½ inch rod pins and quadrant.

E. Multi-Blade Damper:
1. Fabricate of opposed blade pattern with maximum blade length of 48 inches. Dampers with blade lengths exceeding 48 inches shall be sectioned horizontally.
2. Blades shall have 1/8 inch clearance all around and shall operate within duct liner. Provide a channel spacer the thickness of the duct liner.

3. Blades shall not exceed 9 inches high and shall be 16 gauge with 3/8 inch pins and quadrant.
4. Assemble center and edge crimped blades in channel frame with suitable hardware constructed to same materials as duct.

F. End Bearings: Except in round ductwork 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings. Ventlock #607, Duro Dyne or approved equal.

G. Quadrants:
1. Provide locking, indicating quadrant regulators on single and multi-blade dampers.
2. Quadrant shall clearly indicate the position of the damper. Where rod lengths exceed 30 inches provide regulator at both ends.
3. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters. Ventlock #637 for insulated ducts and Ventlock #635 for un-insulated ducts, Duro Dyne, or approved equal.

H. Dampers located above ceilings and in non-accessible locations shall be equipped with Ventlock #666 concealed regulator. Miter gears and universal joints shall be used if required.

2.5 SPIN-IN FITTINGS

A. Manufacturers (Refer to Section 23 05 00):
1. Green Seam (GSI)

B. Sheet metal conical spin-in type round branch take-off for ducts constructed to pressure class 2” and under. Minimum 26 gauge, Assembly shall be designed and tested to meeting SMACNA leakage class 3

C. Assembly to include:
1. Die cast insert (dead end) constructed of zinc-aluminum alloy
2. Damper clips-18 gauge G-60 galvanized steel
3. Damper blade-24 gauge G-60 galvanized steel. Damper blades that are 12” diameter and larger shall be stiffened
4. Stand-off hardware bracket
5. Approved hardware options:
   a. Rossi 3/8” rod damper, cast resin ¾” bushing, super tough engineering 6/6 nylon resin handle, stamped regulator, locking knob
   b. Windgate 3/8 rod damper, 3/8” dial18 gauge galvanized steel regulator, 3/8” cast resin bushing, 16 gauge galvanized steel handle, forged steel wing nut lock

D. Where duct sizes allow, conical fittings shall be utilized. Where rectangular duct sizes do not allow a conical fitting, a straight tap shall be substituted.

PART 3 - EXECUTION

3.1 PREPARATION

A. Verify that electric power is available and of the correct characteristics.

3.2 INSTALLATION

A. Provide accessories as indicated, in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible. Refer to Section 23 31 00 for duct construction and pressure class.

B. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, and elsewhere as indicated. Access doors shall be maximum size to fit ductwork up to 24 inches square for duct sizes larger than 24 inches. Provide larger size access doors where indicated on drawings. Review locations prior to fabrication.

C. Provide duct test holes where indicated and required for testing and balancing purposes.

D. Install dampers with sufficient clearance from duct transitions and other equipment to prevent binding. Provide balancing dampers at points on supply, return, and exhaust duct systems as required for air balancing as indicated on the plans. Install minimum 2 duct widths from duct take-off. Install concealed damper and regulator and coverplate where dampers are located above inaccessible ceilings.

E. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

F. Provide spin-in fittings to connect rigid or flexible low pressure round ducts to rectangular ductwork.

G. Provide air turning devices as specified in Section 23 33 00. Do not install in grease ducts or dryer exhaust. Not required in short return air transfer ducts which transfer air from a room to a ceiling plenum or from one room to another.

H. Temperature control dampers furnished under Section 23 09 23 shall be installed under this section.

I. Provide access doors (in building walls, ceilings) as required to access ductwork accessories unless indicated to be provided under other Divisions. Access doors shall comply with Division 8.

END OF SECTION

SECTION 23 34 00

HVAC FANS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. In-line centrifugal fans (belt drive)

B. In-line centrifugal fans (direct drive)

C. High Volume Low Speed (HVLS) fans

D. Vehicle exhaust utility set fans (belt drive)

1.2 RELATED SECTIONS

A. Section 23 05 00 – Common Work Results for HVAC

B. Section 23 05 13 – Common Motor Requirements for HVAC Equipment

C. Section 23 05 48 – Vibration Isolation

D. Section 23 09 23 – Direct-Digital Control for HVAC

E. Section 23 31 00 – HVAC Ducts and Casings

F. Section 23 33 00 – Air Duct Accessories

1.3 REFERENCES

A. AMCA 99 - Standards Handbook

B. AMCA 210 - Laboratory Methods of Testing Fans for Rating Purposes

C. AMCA 261 - Directory of Products Licensed to Bear the AMCA Certified Ratings Seal

D. AMCA 300 - Test Code for Sound Rating Air Moving Devices

E. AMCA 301 - Method of Publishing Sound Ratings for Air Moving Devices

F. NEMA MG1 - Motors and Generators

G. UL 705 - Power Ventilators

1.4 SUBMITTALS FOR REVIEW (REFER TO SECTION 23 05 00)

A. Product Data: Provide data on fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels at rated capacity, dimensions, weights, connections, and electrical characteristics and connection requirements. List all options and accessories furnished with each fan.

1.5 OPERATION AND MAINTENANCE MATERIALS (REFER TO SECTION 23 05 00)

A. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.6 QUALITY ASSURANCE

A. Applicator Qualifications: Fan shall be manufactured by a Company regularly engaged in the production of such equipment and who issues complete catalog data.

B. Fans shall not increase motor size or increase noise level, or increase inlet air velocity by more than 10 % from specified criteria.

C. Do not operate fans until ductwork is clean, filters are in place, and bearings are lubricated.

1.7 REGULATORY REQUIREMENTS

A. Fan performance ratings shall be AMCA certified in accordance with AMCA 210. Fans shall bear the AMCA sticker.

B. Sound ratings shall be AMCA certified in accordance with AMCA 300.

C. All fans shall be UL listed in accordance with UL 705. Fans shall bear the UL listing mark.

1.8 EXTRA MATERIALS (REFER TO SECTION 23 05 00)

A. Supply extra belts and sheaves as required for each fan for use during air balance, at no extra cost to the Owner.

B. Supply one (1) spare set of belts and bearings for each fan at project closeout.

PART 2 - PRODUCTS

2.1 GENERAL

A. Motors shall be in conformance with Section 23 05 13.

B. Fans shall be statically and dynamically balanced.

C. Consult drawings for sizes, model numbers, capacities, electrical characteristics, and accessories.

2.2 IN-LINE FANS

A. Manufacturers (Refer to Section 23 05 00):
1. Cook
2. Greenheck
3. Penn
4. Twin City

B. Centrifugal In-Line Fans (Belt Drive)
1. Construction: Heavy gauge galvanized steel; insulated housing; square duct mounting collars on inlet and outlet; minimum of two removable panels providing adequate service access to all internal parts.
2. Wheel: Centrifugal, backward inclined, aluminum fan wheel; precision cast aluminum hub; aerodynamic aluminum inlet cone designed to provide maximum performance and efficiency.
3. Bearings: Permanently lubricated and sealed, or regreasable heavy duty pillow block type; minimum L-50 life in excess of 200,000 hours at maximum catalogued operating speed.
4. Belts and Drives: Oil and heat resistant, non-static type belts; precision ground drive securely keyed to the wheel and motor shafts; drives shall be sized for 150 % of the installed motor horsepower; cast iron, multi-belt sheaves - adjustable for motors up to 5 hp and fixed for motors in excess of 5 hp.
5. Motor Cover/Belt Guard: Galvanized steel construction; adequate for protection of motors, drives, and personnel.
6. Safety Screens: Galvanized mesh safety screens provided on all un-ducted inlet and discharge openings. Screens shall be easily removable for maintenance and inspection.
7. Motorized DamperExtruded aluminum construction; brass bushings; see drawings for motor voltage; voltage shall be verified with Section 23 09 23 and Division 26 prior to ordering. Actuators shall be 24 Volt Belimo, two position dampers unless indicated otherwise on the drawings.
8. Vibration Isolation: Spring and neoprene isolators consisting of a steel spring in series with a neoprene isolation element; sized to match each fan; designed to support five times overload without failure and allow up to 15 degrees of hanger rod misalignment; hanging isolators for suspended fans and base isolators for floor-mounted fans

C. Centrifugal In-Line Fans (Direct Drive)
1. Construction: Heavy gauge galvanized steel; insulated housing; square duct mounting collars on inlet and outlet; minimum of two removable panels providing adequate service access to all internal parts.
2. Wheel: Centrifugal, backward inclined, aluminum fan wheel; precision cast aluminum hub; aerodynamic aluminum inlet cone designed to provide maximum performance and efficiency.
3. Safety Screens: Galvanized mesh safety screens provided on all un-ducted inlet and discharge openings. Screens shall be easily removable for maintenance and inspection.

4. Motorized Damper Extruded aluminum construction; brass bushings; see drawings for motor voltage; voltage shall be verified with Section 23 09 23 and Division 26 prior to ordering. Actuators shall be 24 Volt Belimo, two position dampers unless indicated otherwise on the drawings.
5. Vibration Isolation: Spring and neoprene isolators consisting of a steel spring in series with a neoprene isolation element; sized to match each fan; designed to support five times overload without failure and allow up to 15 degrees of hanger rod misalignment; hanging isolators for suspended fans and base isolators for floor-mounted fans

2.3 HIGH VOLUME LOW SPEED (HVLS) FANS

A. Manufacturers (Refer to Section 23 05 00):
   1. Big Ass Fans
   2. Hunter
   3. Or approved equal

B. High Volume Low Speed Fans
   1. The fan shall be ETL/Intertek certified pursuant to ANSI/UL 507 and CSA C22.2No.113 in North America.
   2. The fan shall be compliant with NFPA 13, NFPA 72 and NFPA70-2011.
   3. The manufacturer shall replace any components defective in material or workmanship free of charge pursuant to the complete terms and conditions of Hunter Industrial's Limited Lifetime Warranty in accordance to the following summary:
      a. Airfoils Limited Lifetime
      b. Hub and Blade Holder Limited Lifetime
      c. Gearless Motor Limited Lifetime
      d. Variable Frequency Drive 10 Year (Parts)
      e. HMI Controller 8 Years (Parts)
      f. All other components Limited Lifetime (Parts)
      g. Labor 1 Year

C. Complete Unit
   1. Regulatory Requirements: The fan shall be Intertek/ETL certified pursuant to ANSI/UL 507 and CSA standard 22.2 No. 113 in North America.
   2. Sustainability and Efficiency: The fan shall be designed to move an effective amount of air for cooling and destratification in a wide variety of applications. The entire fan and components shall not weigh more than 159 lbs. to reduce stress on building structure.

D. Industrial Control Panel
   1. The fan controller shall consist of a Variable Frequency Drive (VFD) enclosed in an aluminum enclosure. This enclosure is designed to contain the VFD for maximum cooling efficiency and is pre-wired through the downrod along with receptacles and electrical whip for a plug-n-play install. An external relay for integration to existing fire panels is optional.
   2. Available voltages: as scheduled on the drawings.

E. Airfoil System The fan shall be equipped with four (4) airfoils made from 6005A Structural Grade aluminum. The airfoils shall be connected to the hub by means of a

high strength pressed bolt system. Each airfoil shall be manufactured with a precision cut, swept style tip (instead of winglets).

F. Hub Motor
1. The fan motor shall be a high torque permanent magnet motor (also referred to as a brushless DC, electronically commutated, or synchronous) rated for continuous operation at maximum speed without the use of a gearbox or other mechanical torque multiplier. The motor shall be a totally enclosed non-ventilated design with the capacity for continuous operation in 32° to 140° F ambient conditions. The hub motor enclosure shall be precision cast A380 for low weight and maximum strength.

G. Mounting System The mounting system shall be designed for quick, secure installation to a wide variety of ceiling structural supports. All components of the mounting system shall be made from A36 steel and ERW tubing. The downrod shall be pre-wired and pre-assembled with adjustable length capabilities. The downrod shall have a pin and sleeve connection to the motor for simple, safe and economical installation. All mounting bolts shall be SAE Grade 5 or equivalent.

H. Safety Cables
1. The fan shall be equipped with one 1/4" 7 x 19 Safety Cable, the length of the downrod plus six feet, composed of high-tensile ANSI 316 stainless steel. The minimum breaking strength of the cable assembly supplied is 4,750 lbs. Wire rope conforms to ASTM A492. In addition, three ¼” malleable wire rope clamps will be included.

I. Guywires
1. The fan shall be equipped with a custom guywire system comprised of four separate components:
   a. A beam clamp with a swivel for inclined application supplied with a high tensile setscrew for a secure grip on both parallel and tapered flanges.
   b. Turnbuckle design to be tightened by hand with brass tip set screws to prevent loosening.
   c. Gripple, a locking fastener that is wire-diameter specific, for terminating cable when bracing and suspending static and dynamic loads. After install, locking screws can be fully inserted to secure the internal wedges in place.
   d. Guywire cable, 1/8” 7 x7 wire rope with integrated hook for quick and easy attachment to the provided beam clamp. 1 cable at 2’, 1 cable at 15’ H.

2.4 VEHICLE EXHAUST UTILITY SET FANS (BELT DRIVEN)

A. Manufacturers (Refer to Section 23 05 00):
1. Car-Mon
2. Ventaire
3. Eurovac
4. Approved Equal

B. Vehicle Exhaust Fans (ECU)
1. Rated in accordance with AMCA Standards 210 and bear the AMCA seal.
2. Standard equipment includes: Belt guards, turned ground and polished fan shafts, variable pitch Vbelt motor drives, two groove pulleys with matched belts standard for fan size 122 and larger, adjustable motor bases, and high efficiency, non-

overloading, backward inclined wheels of heavy duty construction. All parts in the air stream are coated with a polyester powder coating. Fan housings are fabricated of heavy gauge steel and are continuously welded. All fans are run tested at the factory and checked for compliance with rigid balance standards. Clockwise rotation wheels and bottom horizontal discharge are standard. Either rotation and any one of 8 different discharge positions may be specified at time of order.

3. Fan shall be provided with platform for suspension from structure.
4. Fan shall be rated for use in vehicle exhaust collection systems.
5. Fan shall be provided with vibration pad and rails.
6. Fan shall be provided with inlet and outlet flexible connections, provided by the fan manufacturer, rated for high temperature use.Refer to Section 23 05 48.
7. Provide clean out caps as required by the manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General
1. Provide in accordance with the manufacturers requirements and as indicated on the drawings.
2. Provide vibration isolation in accordance with Section 23 05 48.
3. Install accessories furnished with the fans.

B. HVLS Fans
1. Preparation
a. An existing building must have a mounting structure able to support two times the hanging weight of the fan. The structure the fan is attached to shall be capable of supporting a torque load of up to 70 ft·lb of torque.
b. Minimum Clearances
1) Airfoils must be at least 10ft above the floor.
2) The sweep area (horizontally and vertically) must be at least 2ft from any obstructions such as lights and cables.
c. Item such as lights, cables, or any other obstacles must be relocated or removed if they do not comply with the minimum clearance requirement before installation.
d. Dedicated branch circuit protection is required to the fans.
e. A twist lock receptacle must be placed 5 feet outside the sweep area. Refer to the installation manual for a list of receptacles part numbers.
2. Any installation shall be performed in accordance with the manufacturer’s installation manual. This includes acceptable structural dimensions and proper sizing and placement of all installations.
3. In buildings equipped with sprinklers, you must comply with NFPA 13 and NFPA 72 guidelines for application of these fans.

END OF SECTION

SECTION 23 35 16

ENGINE EXHAUST SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Complete carbon monoxide removal system with:
   1. Ductwork – Above Grade
   2. Accessories
   3. Refer to Section 23 34 00 for vehicle exhaust fans

1.2 RELATED SECTIONS

A. Section 23 05 00 – Common Work Results for HVAC

B. Section 23 05 13 – Common Motor Requirements for HVAC Equipment

C. Section 23 05 17 – Sleeves and Sleeve Seals for HVAC

D. Section 23 05 29 – Hangers and Supports for HVAC Piping and Fittings

E. Section 23 34 00 – HVAC Fans

1.3 REFERENCES

A. ASTM A 36 - Structural Steel

B. ASTM A 167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip

C. ACGIH - Industrial Ventilation, A Manual of Recommended Practice

D. SMACNA - HVAC Duct Construction Standards - Metal and Flexible

E. SMACNA - Round Industrial Duct Construction Standard

1.4 PERFORMANCE REQUIREMENTS

A. Drawings showing duct arrangements are diagrammatic only and do not attempt to show all offsets and fittings required. The contractor shall adjust the work as required to facilitate installation, COORDINATE WITH STRUCTURE AND OTHER TRADES. See Section 23 05 00, - “Locations”.

B. If changes of duct configuration or sizes are required to facilitate installation, obtain written permission from Owner's Representative before proceeding with fabrication and installation.

1.5 SUBMITTALS AT PROJECT CLOSEOUT

A. Refer to Section 23 05 00

B. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA HVAC Air Duct Leakage Test Manual. Furnish for O&M Manual.

C. Project Record Documents
1. Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

D. Operation and Maintenance Data
1. Submit under provisions of Section 23 05 00.
2. Operation and Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 23 05 00.

B. Operation and Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.7 QUALITY ASSURANCE

A. System shall be standard product of a carbon monoxide exhaust system manufacturer.

B. Perform Work in accordance with SMACNA - HVAC Duct Construction Standards - Metal and Flexible, latest edition and SMACNA - Round Industrial Duct Construction Standard, latest edition.

C. Maintain one copy of document on site.

1.8 REGULATORY REQUIREMENTS

A. Products Requiring Electrical Connection: UL listed and classified.

B. Construct ductwork to the International Mechanical Code, and SMACNA, HVAC Duct Construction Standards - Metal and Flexible, Latest Edition and SMACNA - Round Industrial Duct Construction Standard, latest edition.

C. Where more than one standard is referenced, the most restrictive shall apply.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.

B. Maintain temperatures during and after installation of duct sealants.

PART 2 - PRODUCTS

2.1 GENERAL MATERIALS

A. Stainless Steel Ducts: ASTM A167, Type 304

B. General Materials: rated for 600 degrees F.

C. Sealants for metal ductwork: System is welded, no sealants required.

D. Hanger Rod: ASTM A36; galvanized steel; threaded both ends, threaded one end, or continuously threaded

2.2 DUCTWORK AND DUCT ACCESSORIES (ABOVE GROUND)

A. Manufacturers (Refer to Section 23 05 00):
1. United McGill Corp, Industrial Duct and Fittings

B. Construction
1. Stainless Steel Ducts: Type 304, fully welded.
2. Longitudinal Seam
3. Fabricate in accordance with SMACNA Round Industrial Duct Construction Standard and ACGIH Industrial Ventilation manual except as indicated.
4. Fittings shall be fully welded with overlapping seam and factory sealed over the entire seam.
5. Construct T's, bends, and elbows with radius of not less than 2 ½ times width of duct on centerline.
6. Increase duct sizes gradually, not exceeding 15 degrees.
7. Provide standard 45 degree lateral wye branch fittings unless otherwise indicated.
8. Fittings shall be equal to United McGill Corp. as follows:
   a. Elbows: SRNE 7-90, SRNE 2-45, SRNE 3-60
   b. Laterals: SRNLP, SRNL, SRNLR
   c. Concentric expander: SRNR

2.3 FLEXIBLE TUBING

A. Manufacturers (Refer to Section 23 05 00):
1. Basis of Design: Carmon Type HTC
2. Eurovac
3. Ventaire
4. Approved Equal

B. B. The exhaust hose shall be fabricated of silicone coated glass fabric inner layer and silicone coated nomex outer layer, clinched within an external galvanized steel helix. No adhesives may be used in the construction. The flexible hose is to be capable of withstanding temperatures of 1000°F interior, and be both flame retardant and oil resistant. Exhaust adapters, rings, flanges, etc., if furnished, shall be attached to the hose at the factory to insure the integrity of the assembly. Field assembly is not acceptable.

2.4 RETRACTION EQUIPMENT

A. Manufacturers (Refer to Section 23 05 00):
1. Basis of Design: Carmon Series LFT 25
2. Eurovac
3. Ventaire
4. Approved Equal

B. The Series LFT Retractor tubing suspension system is designed to support the flexible tubing from overhead when not in use, allowing it to be lowered to the operating level when required. The lifting device is a single spring retractor with ratchet stop and ¼" steel suspension frame with cast eyelet and heavy-duty snap ring. Provide with safety chain, mounting eye, ¼” steel plate frame with exposed spring, ratchet stop, aluminum cable storage spool, adjustable cable styop, high tensile vinyl coated cable, and latch ring.

C. Provide with CTA-8 tailpipe adapter, hand damper, tube sling, spring lifter, and flange set.

2.5 TAILPIPE ADAPTERS

A. Manufacturers (Refer to Section 23 05 00):
1. Basis of Design: Carmon Type CTA-8
2. Eurovac
3. Ventaire
4. Approved Equal

B. Clamping type adapters are of 20 ga. stainless steel construction, with locking vise grip type clamp. They are specifically designed for applications where a secure connection is needed. Standard features include SafeT-Edge for safe handling, heavy duty locking vise grip, and an exhaust analyzer opening for emission testing.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide in accordance with manufacturer’s instructions and as indicated on the drawings.

B. General installation requirements in Section 23 31 00 apply to this section.

C. Provide and support ducts in accordance with SMACNA - Round Industrial Duct Construction Standard and the manufacturer's recommendations.

D. Weld in accordance with SMACNA HVAC Duct Construction Standards. Metal and flexible and as specified for the specified pressure class and sealant class.

E. Support ductwork at minimum every 12 feet and design to support ductwork full of material.

F. Provide blast gates at each drop or branch fitting. Blast dampers shall be stainless steel.

G. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

H. Use double nuts and lock washers in threaded rod supports.

3.2 CLEANING

A. See Section 23 31 00.

3.3 SCHEDULES

A. Ductwork Material and Pressure Class Schedule

Air System	**Negative Pressure Class inches WG**	**Minimum Gauge/Material**	**Duct Size**
Engine Exhaust	6	16/304 Stainless Steel	16" and smaller
Engine Exhaust	10	14/304 Stainless Steel	Ducts greater than 16"

B. Sealants

Pressure Class inches WG	**Sealant Class**	**Description**
4 and greater	Class A	Seal all longitudinal and transverse joints and seams with welding

3.4 FIELD QUALITY CONTROL

A. Testing (Refer to Section 23 05 00)
1. Exhaust ducts and plenums shall be leak-tested at 6" pressure in accordance with the SMACNA HVAC Air Duct Leakage Test Manual and shown to have a rate of air leakage (CL) less than or equal to 4.0 as determined in accordance with the follow equation:

a. $CL - F/P^{0.65}$
b. F = The measured leakage rate in cfm per 100 square of duct surface.
c. P = The static pressure of the test.

2. Documentation shall be furnished to the Owner's Representative demonstrating that representative sections totaling 100 percent of the duct area have been tested and that all tested sections meet the requirements of this section.
3. Leakage concentrated at one point may result in objectionable noise even if the system passes the leakage rate criteria. The noise source shall be corrected to the satisfaction of the engineer.
4. Perform tests in the presence of the Owner's Representative. Owner's Representative shall sign test reports as witness. Submit final reports for inclusion in O&M Manual.

END OF SECTION

SECTION 23 36 00

AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Round Pressure Independent Terminal units for General Exhaust Applications

B. Fan-Powered Terminal Units

C. Single Duct Terminal Units

1.2 RELATED SECTIONS

A. Section 23 05 00 – Common Work Results for HVAC

B. Section 23 05 13 – Common Motor Requirements for HVAC Equipment

C. Section 23 05 48 – Vibration Isolation

D. Section 23 09 23 – Direct-Digital Control for HVAC

E. Section 23 21 13 – Hydronic Piping

F. Section 23 21 16 – Hydronic Piping Specialties

G. Section 23 31 00 – HVAC Ducts and Casings

1.3 REFERENCES

A. General

B. ARI 880-94 - Industry Standard for Air Terminals

C. NFPA 90A - Installation of Air Conditioning and Ventilation Systems

D. UL 181 - Factory-Made Air Ducts and Connectors

E. NFPA 70 - National Electrical Code

1.4 SUBMITTALS FOR REVIEW (REVIEW TO SECTION 23 05 00)

A. Product Data: Provide data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings which indicate air flow, static

pressure, and NC designation. Include electrical characteristics and connection requirements.

B. Submit schedule of air terminal units in same format as scheduled on the drawings indicating the performance of each air terminal unit at the specified operating conditions.

C. Submit electrical characteristics and connection requirements.

D. For active equipment with an Ip=1.5 in seismic design criteria (SDC) levels C through F and a weight greater than 20 pounds, submit the manufacturer's certificate that equipment is seismically qualified by one of the criteria allowed in Section 23 05 49. See Section 23 05 49 for equipment Ip factors, seismic design criteria, and active equipment definitions. Product submittals without accompanying certificates will be rejected.

1.5 PROJECT RECORD DOCUMENTS (REFER TO SECTION 23 05 00)

A. Record actual locations of air terminal units, service areas and piping connections.

1.6 OPERATION AND MAINTENANCE DATA (REFER TO SECTION 23 05 00)

A. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include directions for resetting volume regulators.

1.7 REGULATORY REQUIREMENTS

A. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories Inc., as suitable for the purpose specified and indicated.

1.8 DRAWING SCHEDULES

A. Refer to equipment schedules on drawings for additional information.

PART 2 - PRODUCTS

2.1 GENERAL AIR TERMINAL UNITS

A. Manufacturers (Refer to Section 23 05 00):
1. Krueger
2. Price
3. Titus

B. VAV Supply Terminal Units with/without reheat
1. Construction: Minimum 22-gauge galvanized steel casing; round stub air inlet connections in sizes noted on the drawings; slip and drive air outlet connection.

2. Dampers: Galvanized steel volume damper(s) with peripheral gasket and self-lubricating bearings; maximum allowable damper leakage 2 % of design airflow at 3-inch inlet static pressure; linkages for damper as necessary; protective metal shroud for controls components; plenum air inlet, when provided, shall have finished metal edges with no exposed insulation and frame for attachment of 1 inch throwaway filter.
   a. Fiberglass Liner (Standard): ½ inch, 1.5 pounds/feet³ density fibrous glass insulation meeting NFPA 90A flame and smoke requirements and UL 181 erosion requirements; black pigmented insulation coating conforming to NFPA 90A to resist erosion at velocities up to 5,000 FPM; exposed edges of liner coated with an NFPA 90A approved sealant to prevent entrainment of fibers in the airstream. Casing insulation shall be installed in a manner to preclude any raw edges or surfaces from contact with the airstream. Provide an EPA registered, anti-microbial agent on the surface coating so that the liner will not support the growth of fungus or bacteria. Anti-microbial agent shall be tested in accordance with fungi test ASTM C665 and G21 and bacterial test ASTM G22.
3. Flow Sensors: Cross or annular ring configuration; located at the inlet of the terminal unit; multiple pressure sensing ports with averaging chamber; sensor shall provide amplified signal; 5 % accuracy with a 90-degree sheet metal elbow directly at the inlet of the assembly; external taps provide for calibration. An airflow (CFM) curve shall be affixed to the terminal unit expressing differential vs. CFM.
4. Hot Water Heating Coil: Copper tube mechanically expanded into aluminum plate fins; leak-tested to 300 psi; 2000 psi minimum burst pressure at ambient temperature; factory installed as an integral part of air terminal unit. Coil shall be rated in accordance with ARI standard 410 and tested in accordance with ASHRAE standard 33. All coils shall be provided with a manual air vent fitting. Valve core type vent fittings are not acceptable. Coils shall be rated for a minimum of 200 °F
5. Controllers and Actuators: Furnished by Section 23 09 23 and shipped to the terminal unit manufacturer for factory installation. Coordinate with Section 23 09 23 for actuator and controller requirements.
6. Certification: Air terminal units shall be certified under ARI standard 880-94 Certification Program and shall carry the ARI seal.
7. Accessories:
   a. Unit casing shall have a 4” x 6.75” internally insulated bottom access with quarter turn sash what allows servicing of unit without disturbing duct connections. Terminal units with matt faced liner finish shall have dual wall construction. Perimeter shall be gasketed. Access door shall be located between the damper and the reheat coil.

C. Round Pressure Independent Terminal units for General Exhaust Applications
1. Construction: Minimum 22-gauge galvanized steel casing with minimum 3 concentric rolled beads to ensure units are round; round air inlet and outlet connections in sizes noted on the drawings.
2. Dampers: galvanized steel volume damper(s) with peripheral gasket and self-lubricating bearings; maximum allowable damper leakage 2 % of design airflow at 3-inch inlet static pressure; linkages for damper as necessary. Shafts shall be clearly marked on the end to indicate damper position (sticker or other removeable markings are not acceptable. The damper shall incorporate a mechanical stop to prevent over stroking and a synthetic seal to limit close-off leakage to the maximum values
3. Flow Sensors: Cross or annular ring configuration; located at the inlet of the terminal unit; minimum of 4 pressure sensing/measuring ports in parallel with the take-off

point from the sensor; sensor shall provide amplified signal; 5 % accuracy with a 90-degree sheet metal elbow directly at the inlet of the assembly; external taps provide for calibration. Sensor must provide a signal measurable by the controller at inlet velocities of 500 FPM. An airflow (CFM) curve shall be affixed to the terminal unit expressing differential vs. CFM.

4. Controllers and Actuators: Furnished by Section 23 09 23 and shipped to the terminal unit manufacturer for factory installation. Coordinate with Section 23 09 23 for actuator and controller requirements.
5. Certification: Air terminal units shall be certified under ARI standard 880-94 Certification Program and shall carry the ARI seal.
6. Basis of Design: Price RDV Series

D. Fan-Powered Terminal Units
   1. General: Unit shall have a single point electrical and control connection. Mount electrical components in control box with removable cover. Terminal strip in control box for field wiring of thermostat and power source.
   2. Fans: Forward curved, centrifugal type; dynamically balanced fan wheel; anti-backward rotation design; permanent split capacitor type motor; thermally protected; permanently lubricated bearings; assembly mounted on rubber isolators.
   3. Construction: Minimum 22-gauge galvanized steel casing; round stub air inlet connections in sizes noted on the drawings; slip and drive air outlet connection.
   4. Dampers: Galvanized steel volume damper(s) with peripheral gasket and self-lubricating bearings; maximum allowable damper leakage 2 % of design airflow at 3-inch inlet static pressure; linkages for damper as necessary; protective metal shroud for controls components; plenum air inlet, when provided, shall have finished metal edges with no exposed insulation and frame for attachment of 1 inch throwaway filter.
      a. Fiberglass Liner (Standard): ½ inch, 1.5 pounds/feet³ density fibrous glass insulation meeting NFPA 90A flame and smoke requirements and UL 181 erosion requirements; black pigmented insulation coating conforming to NFPA 90A to resist erosion at velocities up to 5,000 FPM; exposed edges of liner coated with an NFPA 90A approved sealant to prevent entrainment of fibers in the airstream. Casing insulation shall be installed in a manner to preclude any raw edges or surfaces from contact with the airstream. Provide an EPA registered, anti-microbial agent on the surface coating so that the liner will not support the growth of fungus or bacteria. Anti-microbial agent shall be tested in accordance with fungi test ASTM C665 and G21 and bacterial test ASTM G22.
   5. Flow Sensors: Cross or annular ring configuration; located at the inlet of the terminal unit; multiple pressure sensing ports with averaging chamber; sensor shall provide amplified signal; 5 % accuracy with a 90-degree sheet metal elbow directly at the inlet of the assembly; external taps provide for calibration. An airflow (CFM) curve shall be affixed to the terminal unit expressing differential vs. CFM.
   6. Hot Water Heating Coil: Copper tube mechanically expanded into aluminum plate fins; leak-tested to 300 psi; 2000 psi minimum burst pressure at ambient temperature; factory installed as an integral part of air terminal unit. Coil shall be rated in accordance with ARI standard 410 and tested in accordance with ASHRAE standard 33. All coils shall be provided with a manual air vent fitting. Valve core type vent fittings are not acceptable. Coils shall be rated for a minimum of 200 °F
   7. Controllers and Actuators: Furnished by Section 23 09 23 and shipped to the terminal unit manufacturer for factory installation. Coordinate with Section 23 09 23 for actuator and controller requirements.

8. Certification: Air terminal units shall be certified under ARI standard 880-94 Certification Program and shall carry the ARI seal.
9. Accessories:
   a. Unit casing shall have a 4” x 6.75” internally insulated bottom access with quarter turn sash what allows servicing of unit without disturbing duct connections. Terminal units with matt faced liner finish shall have dual wall construction. Perimeter shall be gasketed. Access door shall be located between the damper and the reheat coil.
   b. Provide manual speed controller to allow manual fan speed adjustment to specified airflow in the field. Speed controller shall have minimum voltage stop to preclude operation install mode. Provide with control voltage transformer (24 V).
   c. Provide with a 0-10VDC controller to allow fan speed adjustment from BAS (Section 23 09 23).
   d. Provide with control voltage transformer (24V).
   e. Provide with 1-inch-thick throwaway filter.
10. Basis of Design
    a. Parallel Configuration: Price FDV

PART 3 - EXECUTION

3.1 GENERAL

A. Verify that electric power is available and of the correct characteristics.

B. Provide in accordance with manufacturer’s instructions and as indicated.

C. Provide ceiling access doors to access air terminal units unless these terminal units are located above accessible T-Bar ceilings or access doors are indicated to be provided under other divisions. Access doors shall comply with Division 8.

3.2 INSTALLATION

A. General
   1. Support units individually from structure. Do not support from adjacent ductwork.
   2. Provide a 30-inch minimum or (3) duct diameter, whichever is greater) straight section of sheet metal ductwork at inlet to terminal unit or air valve of same size as terminal inlet. When duct serving terminal unit is not of the same size as the inlet, a duct transition shall be provided upstream of this straight section.
   3. Connect to ductwork in accordance with Section 23 31 00.
   4. Provide minimum of 10 feet of 1-inch-thick lined ductwork downstream of units.
   5. Controllers and actuators furnished under Section 23 09 23 shall be shipped to the terminal unit manufacturer for factory installation. Controls shall be installed such that dampers are normally open unless noted otherwise on the drawings (exception: actuators for cold-deck dampers shall be installed such that dampers are normally closed unless noted otherwise on the drawings).

B. Fan-Powered Terminal Units
   1. Fan powered terminal units shall be supported from the structure in accordance with Section 23 05 48.

END OF SECTION

SECTION 23 37 00

AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Grilles, Registers and Diffusers

B. Louvers

1.2 RELATED SECTIONS

A. Division 09 – Painting

B. Division 09 – Suspended Ceilings

C. Section 23 05 00 – Common Work Results for HVAC

D. Section 23 40 00 – Air Cleaning Devices

1.3 REFERENCES

A. AAMA 605.2 - Voluntary Specification for High Performance Organic Coatings on Architectural Extrusions and Panels

B. ADC 1062 - Certification, Rating and Test Manual

C. AMCA 500 - Test Method for Louvers, Dampers and Shutters

D. ARI 650 - Air Outlets and Inlets

E. ASHRAE 70 - Method of Testing for Rating the Air Flow Performance of Outlets and Inlets

F. SMACNA - HVAC Duct Construction Standard - Metal and Flexible

1.4 SUBMITTALS FOR REVIEW (REFER TO SECTION 23 05 00)

A. Product Data:
1. Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission.
2. Submit schedule of outlets and inlets showing type and accessories.
3. Submit performance data for each type of inlet/outlet. Performance data shall show airflows, pressure drops and noise criteria for each size of diffuser.

4. Coordinate grilles, register and diffuser frame types with associated ceiling systems and t-bar widths.

B. Color Samples
1. Submit louver color samples for architect review.

1.5 PROJECT RECORD DOCUMENTS (REFER TO SECTION 23 05 00)

A. Record actual locations of air outlets and inlets.

1.6 QUALITY ASSURANCE

A. Test and rate air outlet and inlet performance in accordance with ADC Equipment Test Code 1062 and ASHRAE 70 – Latest Version.

B. Test and rate louver performance in accordance with AMCA 500

1.7 WARRANTY (REFER TO SECTION 23 05 00)

A. Provide a twenty (20) year Factory Warranty on the louver finish.

1.8 DRAWING SCHEDULES

A. Refer to drawings for specific capacities, dimensions, accessories, and other requirements supplemental to these specifications.

PART 2 - PRODUCTS

2.1 GRILLES, REGISTERS, AND DIFFUSERS

A. General
1. Dampers: Provided when scheduled on the drawings. Dampers shall be opposed blade, heavy gauge steel, and shall be adjustable from the face of the inlet or outlet.
2. Frame types and mounting hardware: Coordinate with ceiling types in the submittal phase. Architectural plans shall take precedence when referencing ceiling types, and Contractor shall reference the architectural plans and specifications for verification of ceiling type and t-bar wdith prior to ordering. When t-bar ceilings are irregular width, provide frames to accomodate t-bar width.
3. Finish: White unless noted otherwise on the drawings.

B. General Grilles, Registers, and Diffusers
1. Manufacturers (Refer to Section 23 05 00):
a. Titus
b. Tuttle & Bailey
c. Anemostat
d. Krueger

e. Price
f. Pottorff

2. See schedules on drawings for basis of design. Diffusers shall meet construction qualities, performance and features of diffusers scheduled on the drawings.

2.2 LOUVERS

A. Manufacturers (Refer to Section 23 05 00):
1. Ruskin
2. Pottorff
3. Greenheck
4. Louvers and Dampers

B. Fabrication:
1. Design: Stationary drainable louver type with drain gutters in each blade and head with downspouts in jambs and mullions with all welded construction. Hidden vertical supports to allow continuous line appearance up to 120 inches (3,048 mm). Steeply angled integral sill.
2. Frame:
   a. Frame Depth: 6 inches.
   b. Wall Thickness: 0.081 inch, nominal.
   c. Material: Extruded aluminum, Alloy 6063-T6, or steel when scheduled on the drawings.
   d. Frame Construction: Standard (no flanges).
3. Blades:
   a. Style: Drainable. 37.5 degrees at 5 -29/32 inches, nominal.
   b. Wall Thickness: 0.081 inch, nominal.
   c. Material: Extruded aluminum, Alloy 6063-T6 , or steel when scheduled on the drawings.
4. Minimum Assembly Size: 12 inches wide by 12 inches high.
5. Maximum Factory Assembly Size: Single sections shall not exceed 120 inches wide by 90 inches high or 90 inches wide by 120 inches high. Louvers larger than the maximum single size shall be require field assembly of smaller sections.
6. Recycled Content: 18% post-consumer. 55% pre-consumer, post-industrial. 73% total by weight.

C. Performance Data:
1. Based on testing 48 inch x 48 inch size unit in accordance with AMCA 500.
2. Free Area: 57 percent, nominal.
3. Free Area Size: 9.08 square feet.
4. Maximum Recommended Air Flow through Free Area: 1023 feet per minute.
5. Air Flow: 9287 cubic feet per minute.
6. Maximum Pressure Drop (Intake): 0.15 inches w.g.
7. Water Penetration: Maximum of 0.01 ounces per square foot of free area at an air flow of 1023 feet per minute free area velocity when tested for 15 minutes.

D. Accessories
1. Bird Screen:
   a. Aluminum: Aluminum, 5/8 inch by 0.040 inch (16 mm by 1 mm), expanded, flattened metal, , or steel when scheduled on the drawings.
   b. Frame: Removable

2. Mullions: Manufacturer's standard horizontal or vertical visible mullions for architectural accent where indicated on architectural elevations. Hidden mullions where not shown on architectural elevations.

E. Finishes
1. Color: Custom. Consult Architect.
2. Finish: Kynar (50 percent PVDF): Finish shall be applied at 1.2 mil total dry film thickness.
3. Coating shall conform to AAMA 2604, sections 4.2 and 4.3. Apply coating following cleaning and pretreatment. Cleaning: AA-C12C42R1X.
   a. Baked Enamel (50% PVDF).

PART 3 - EXECUTION

3.1 GENERAL

A. Provide in accordance with manufacturer's instructions and as indicated on the drawings.

B. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement. Locate air outlets and inlets in accordance with architectural reflected ceiling plan when indicated.

C. On open supply, return or exhaust pressurized duct terminations without louver, grilles, registers or diffusers, provide 1" mesh screen over open duct inlet/outlet in same material/finish as the ductwork. This requirement does not apply to plenum transfer ducts that are not connected to fans.

D. Counterflashing for all roof mounted equipment shall be the responsibility of this section and shall be completely coordinated with the roofing contractor.

3.2 INSTALLATION

A. Grilles, Registers and Diffusers
1. Install diffusers to ductwork with air tight connection.
2. When round ductwork connects to diffusers with square necks, install with a square to round adapter.
3. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, regardless of whether dampers are specified as part of the diffuser, or grille and register assembly and regardless of whether they are shown on the drawings.
4. Paint ductwork visible behind air outlets and inlets matte black. Refer to Division 09.
5. Fasten all pan style diffusers in lay-in ceilings with earthquake tabs.

B. Louvers
1. Examination
   a. Inspect areas to receive louvers. Notify the Owner's Representative of conditions that would adversely affect the installation or subsequent utilization of the louvers. Do not proceed with installation until unsatisfactory conditions are corrected.

b. If opening preparation is the responsibility of another installer, notify Owner's Representative of unsatisfactory preparation before proceeding.

2. Preparation
   a. Clean opening thoroughly prior to installation.
   b. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
3. Installation
   a. Install louvers at locations indicated on the drawings and in accordance with manufacturer's instructions.
   b. Install louvers plumb, level, in plane of wall, and in alignment with adjacent work.
   c. The supporting structure shall be designed to accommodate the point loads transferred by the louvers when subject to the design wind loads.
   d. Install joint sealants as specified in Division 7.
4. Cleaning
   a. Clean louver surfaces in accordance with manufacturer's instructions.
   b. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

SECTION 23 40 00

AIR CLEANING DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Disposable, Extended Area Panel Filters

B. Filter Gauges

C. Ducted Filter Housings

1.2 RELATED SECTIONS

A. Section 23 05 00 – Common Work Results for HVAC

B. Section 23 36 00 – Air Terminal Units

C. Section 23 73 00 – Central Station Air Handling Units

D. Section 23 81 03 – Packaged Ventilation Air Handling Units

E. Section 23 82 00 – Convection Heating and Cooling Units

1.3 REFERENCES

A. ARI 850 - Commercial and Industrial Air Filter Equipment

B. ASHRAE 52 - Method of Testing Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter

C. UL 586 - Test Performance of High Efficiency Particulate Air Filter Units

D. UL 900 - Test Performance of Air Filter Units

1.4 PERFORMANCE TOLERANCES

A. Conform to ARI 850 Section 7.4

B. Dust Spot Efficiency: Plus or minus 5 %

1.5 SUBMITTALS FOR REVIEW (REFER TO SECTION 23 05 00)

A. Provide data on filter media, filter performance data, filter assembly and filter frames, and dimensions, motor locations and electrical characteristics and connection requirements.

1.6 OPERATION AND MAINTENANCE DATA (REFER TO SECTION 23 05 00)

A. Operation and Maintenance Data: Include instructions for operation, changing, and periodic cleaning.

1.7 EXTRA MATERIALS (REFER TO SECTION 23 05 00)

A. In addition to the filters required for operating the equipment, provide an extra set of filters for each piece of equipment.

1.8 QUALITY ASSURANCE

A. Provide all filters as product of one manufacturer. Exception: 1 inch thick panel filters and washable permanent filters.

B. Assemble filter components to form filter banks from products of one manufacturer.

C. Filter access shall be designed so filter can be replaced without use of tools.

PART 2 - PRODUCTS

2.1 GENERAL

A. Manufacturers (Refer to Section 23 05 00):
1. Camfil
2. Cambridge
3. American Air Filter

2.2 DISPOSABLE, EXTENDED AREA PANEL FILTERS (MERV 8)

A. UL 900 Class 2 media, pleated, lofted, non-woven, reinforced cotton and synthetic fabric, supported and bonded to welded wire grid; rigid, heavy duty frame, high wet strength beverage board ASHRAE 52 rated; 25 to 30 % dust spot efficiency; 90 to 92 % weight arrestance.

B. Basis of Design: Farr 30/30.

2.3 DISPOSABLE, EXTENDED AREA PANEL FILTERS (MERV 13)

A. UL 900 Class 2 media, pleated, lofted, non-woven, reinforced cotton and synthetic fabric, supported and bonded to welded wire grid; rigid, heavy duty frame, high wet strength beverage board ASHRAE 52 rated; 80 % to 85 % dust spot efficiency. Merv 13
   1. 2” thick (type 2a), 0.41” APD at 500 FPM (clean)
   2. 4” thick (type 2b), 0.35” APD at 500 FPM (clean)

B. Basis of Design: Camfil Farr AP-Thirteen.

2.4 FILTER GAUGES

A. Manufacturers: (Refer to Section 23 05 00)
   1. Dwyer series 2000, Magnahelic.

B. Direct Reading Dial: 3½ inch diameter diaphragm actuated dial in metal case, vent valves, black figures on white background, front recalibration adjustment, range 0 to 2.0 inches WG, 2 % of full scale accuracy.

C. Accessories: Static pressure tips with integral compression fittings, ¼ inch tubing, 2-way or 3-way vent valves.

2.5 DUCTED FILTER HOUSINGS

A. Manufacturers: (Refer to Section 23 05 00)
   1. Same as filter manufacturer.

B. Basis of Design: Camfil Type 8 Frame
   1. Ability to hold multiple 4” deep MERV 13 pleated filters.

C. Air filter holding frames shall be 16-gauge galvanized steel with filter sealing flange, centering dimples, sealing gasket and lances for appropriate air filter fasteners. The frame shall be assembled from two corner sections and welded to assure a rigid and durable frame assembly.

D. The frame shall include a variety of pre-punched lances for filter fastener attachment. Fastener shall be capable of being installed without the use of tools, nuts or bolts. Lance penetrations shall be upstream of filter flange to assure leak-free integrity.

E. The frame shall include filter centering dimples on each frame wall to facilitate ease of filter installation and assure filter centering against filter sealing flange.

F. A 3/4” filter sealing flange shall be an integral component of the holding frame. All corners shall be flush-mitered and a permanently mounted polyurethane foam gasket shall be mounted on the sealing flange to assure filter-to-frame sealing integrity.

G. Manufacturer shall provide evidence of facility certification to ISO 9001:2015.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide air cleaning devices in accordance with manufacturer's instructions and as indicated.

B. Prevent passage of unfiltered air around filters with felt, rubber, or neoprene gaskets.

C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with clean set.

D. Refer to Section 23 05 00 for filters for temporary heating and ventilating. Filters shall not be less than Farr 30/30.

E. Provide filter gauges on filter banks at all air handling units installed with separate static pressure tips upstream and downstream of filters. (To be factory furnished with air handling unit.) Banks with pre and final filters shall have one (1) gauge with selector or 3-way valve.
   1. Unitary or packaged equipment with filters do not require gauges unless noted.

F. Provide filters in accordance with the schedule.

G. Provide ducted filter housings where noted on the drawings and schedules. Filter housing shall be large enough to accept the quantity of filters indicated in the schedules. Housings shall allow for bottom access and filter removal.

3.2 SCHEDULES

Equipment	**Filter Type**
AHU-1	Quantity 9, 4" Depth x 18" High x 24" Wide, MERV 14 Final
MAU-1	Quantity 6, 2" Depth x 20" High x 25" Wide, MERV 8 Final Quantity 1, 2" Depth x 25" High x 25" Wide, MERV 8 Final Quantity 9, 2" Depth x 20" High x 20" Wide, MERV 8 Final
MAU-2	Quantity 6, 2" Depth x 20" High x 25" Wide, MERV 8 Final Quantity 3, 2" Depth x 25" High x 25" Wide, MERV 8 Final
SSI-1	2" Depth MERV 8 Final, Size by manufacturer.

END OF SECTION

SECTION 23 51 00

BREECHINGS, CHIMNEYS, AND STACKS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Manufactured vents for fuel fired equipment

B. Combustion air intake pipes

C. Vent piping

1.2 RELATED SECTIONS

A. Section 22 30 00 – Plumbing Equipment

B. Section 23 05 00 – Common Work Results for HVAC

C. Section 23 05 48 – Vibration Isolation

1.3 REFERENCES

A. ASTM A167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip

B. ASTM A525 - Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, General Requirements

C. ASTM A527 - Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Lock-Forming Quality

D. ASTM A569 - Steel, Sheet and Strip, Carbon (0.15 % Maximum) Hot-Rolled Commercial Quality

E. NFPA 54 (ANSI Z223.1) - The National Fuel Gas Code

F. SMACNA - HVAC Duct Construction Standards - Metal and Flexible

G. UL 378 - Standard for Draft Equipment

H. UL 441 - Standard for Gas Vents

I. UL 641 - Standard for Low Temperature Venting Systems

1.4 DEFINITIONS

A. Vent: That portion of a venting system designed to convey flue gases directly outdoors from a vent connector or from an appliance when a vent connector is not used

B. Vent Connector: That of a venting system that conducts the flue gases from the flue collar of an appliance to a chimney or vent, and may include a draft control device

1.5 DESIGN REQUIREMENTS

A. Factory built vents used for venting natural draft appliances shall comply with NFPA 211 and be UL listed and labeled.

1.6 SUBMITTALS FOR REVIEW

A. Submit under Section 23 05 00.

B. Shop Drawings: Indicate general construction, dimensions, weights, support and layout of breechings. Submit layout drawings indicating plan view and elevations.

C. Product Data: Provide data indicating factory built vents, including dimensional details of components and flue caps, dimensions and weights, electrical characteristics and connection requirements.

1.7 REGULATORY REQUIREMENTS

A. Conform to applicable code NFPA 54 (ANSI Z223.1) for installation of natural gas propane burning appliances and equipment.

B. Conform to applicable code NFPA 31 (ANSI Z95.1) for installation of oil burning appliances and equipment.

C. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories, Inc., as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 CATEGORY III VENT SYSTEM

A. Manufacturers (Refer to Section 23 05 00):
1. Metalbest
2. Selkirk
3. Amerivent
4. Metal-Fab
5. Schebler Manufacturing

B. UI 1738 listed for positive pressure applications up to 15" w.g and for use on equipment with efficiencies of 83% or less

C. Snap lock design in single wall and make to female slip connections in double wall, secured with self-tapping sheet metal screws. Manufactured with AL29-4C super-ferritic stainless steel for corrosion resistance.

D. Accessories: Thimbles, wall caps, adaptors. Thimbles for gas fired unit heater flue vent terminations shall be GARY STEEL 1092.

2.2 CATEGORY IV APPLIANCE VENTING

A. General:
1. For use on positive pressure venting system.
2. All products shall conform the National Fuel Gas Code, ANSI Z223.1/SFPA-54 where applicable.
3. Vent layout shall be designed and installed in compliance with manufacturer's installation instructions and all applicable local codes.
4. Provide roof terminations for flues in accordance with the boiler manufacturer requirements.
5. The vent system shall be continuous from the appliance's flue outlet to the vent termination outside the building. All systems components shall be UL/cUL listed and supplied by the same manufacturer.
6. All systems components such as vent supports, roof or wall penetrations, terminations, appliance connectors and drain fittings required to install the vent system shall be UL/cUL listed and provided by the vent manufacturer.
7. For exterior applications, outer wall shall be 304 Stainless Steel.

B. Stainless Steel Flue Venting (condensing and non-condensing applications)
1. Manufacturers (Refer to Section 23 05 00):
   a. Saf-T Vent CI Plus (basis of design)
   b. Metal-Fab
   c. Security Chimneys
   d. Duravent
2. UL listed, Category IV listed, double wall air-insulated product for commercial applications.
3. Vent material from one of the approved manufacturers listed in the boiler Installation and Operation manual.
4. Tested and Listed by Underwriters Laboratories to UL 1738/ULC S636 for used with Listed natural gas or propane burning equipment that produce continuous flue-gas temperatures not above 550 F. Also Tested and Listed by Underwriters Laboratories to UL 641/ULC S609 for use with Listed oil and gas burning equipment that are suitable for venting with Type L vent which produce continue flue-gas temperatures not above 570 F. The system is to be installed and sealed per manufacturers' instructions so all joints are gas tight, preventing leakage of products of combustion into a building.
5. Systems shall be a double-wall product that consists of a flue-gas conduit fabricated from AL 29-4C® stainless steel, which is highly suited for use with high-efficiency gas burning equipment, which produce excessive amounts of condensation in the vent. The outer jacket of the system is constructed of type 430 stainless steel with a space of approximately 1" between the flue-gas conduit and the jacket.

6. All joints shall be fastened with closure system that combines the features of tapered ends with a mechanical closure system which consists of tabs and a locking band. The locking band is tightened from a single location using a simple hand tool, pulling the two pieces together making a pressure tight assembly. The joints shall be sealed. Diameters 4” through 16” are manufactured with a factory adhered seal. Diameters shall use an approved sealant on the job site. This closure system is tested to be gas tight at two and one-half times the Listed pressure rating of 15” water column.
7. The system shall be suitable for either interior or exterior installations. The system shall be capable of withstanding wind and incidental loads as required by UL standards.
8. When connected to gas-burning appliances with a maximum continuous flue-gas temperature of 550 F, 4” through 24” diameter venting can be fully enclosed vertically by combustible materials at 1” or greater clearance and 26”-32” diameter by 2” or greater clearance. For horizontal applications refer to the manufacturers’ Clearance Chart.

2.3 COMBUSTION AIR INTAKE VENTING FOR BOILERS

A. This section applies to boilers with sealed/ducted combustion air direct to the appliance.

B. Intake piping must be of approved material as listed in the Boiler Installation and Operations manual. Provide wall terminations for combustion air intakes in accordance with the boiler manufacturer requirements for terminations. Insulate in accordance with Section 23 07 00.

2.4 DIRECT (FLUE GAS) VENTS AND COMBUSTION AIR INTAKE PIPES FOR DOMESTIC HOT WATER HEATERS

A. Provide Schedule 40 CPVC piping (vents) as per boiler and water heater manufacturer requirements. Hollow or cellular core pipe is not allowed.

B. Outdoor terminations shall be protected from UV exposure. Options include CPVC pipe compounded with natural UV inhibitor (titanium dioxide) such as Corzan. Alternate options, include field applied light colored acrylic or latex paint that is chemically compatible with CPVC compounds (compatibility confirmed with the paint manufacturer).

C. Accessories, UL labeled and approved by boiler and water heater manufacturer:
1. Consists of roof termination, penetration, vent flashing with spacers and storm collar to suit roofing material and construction.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide in accordance with manufacturer’s instructions, UL listings, and as indicated.

B. All water heater and boiler combustion intake and flue vent piping, regardless of material, shall be vibration isolated from structure. Refer to Section 23 05 48.

C. Connect full size to appliance connections.

D. Install in accordance with NFPA 211, 37, NFPA 54 (ANSI Z223.1.) NFPA 31 and UL listing.

E. Install chimneys and vents with minimum of joints. Align accurately at connections, with internal surfaces smooth.

F. Support chimneys and vents from building structure, rigidly with suitable ties, braces, hangers and anchors to hold to shape and prevent buckling. Support chimneys and vents and stacks at 12 feet maximum spacing, to adjacent structural surfaces, or at floor penetrations. Refer to SMACNA HVAC Duct Construction Standards - Metal and Flexible for equivalent duct support configuration and size and spacing.

G. Install concrete inserts for support of chimneys and vents and stacks in coordination with formwork.

H. For factory built chimneys and vents, maintain UL listed minimum clearances from combustibles. Assemble pipe and accessories as required for complete installation and in accordance with manufacturer’s recommendations.

I. Assemble and install double wall vent and chimney sections in accordance with NFPA 211, industry practices, and in compliance with UL listing. Join sections with acid-resistant joint cement to ASTM C105. Connect base section to foundation using anchor lugs.

J. Joint cement or sealant for double wall vent and chimneys shall be as recommended by the manufacturer and UL listing for the application.

K. Level and plumb vents and chimneys and stacks.

L. Clean vents, chimneys, and stacks during installation, removing dust and debris.

M. At appliances, provide slip joints permitting removal of appliances without removal or dismantling, chimneys, vents, insulation or stacks.

N. Make provisions for condensate drainage from venting and chimney system and exhaust systems. Pipe drain from tees to nearest floor drain.

O. Provide all fittings, thimbles, flashing, etc., for a complete installation and terminate flue terminations and sealed combustion air intakes in accordance with code requirements with manufactured approved vent and intake caps.

P. Provide neoprene wrap between supports and double wall vents and chimneys.

Q. Coordinate installation of dampers and induced draft fans. Install vent dampers, locating close to draft hood collar, and secured to vent.

R. Provide chimneys and vents in accordance with the schedule.

S. Follow the agency certified Category III vent manufacturer’s instructions for installation for all horizontally vented gas fired unit heaters.

T. All gas fired unit heaters must be terminated with manufacturer approved listed vent cap.

3.2 SCHEDULES

Equipment	**Chimney/Vents**
Boiler- Condensing	Category IV Stainless Steel
Gas Fired Unit Heater	Category III Vent
Water Heater-High Efficiency	Schedule 40 CPVC

END OF SECTION

SECTION 23 52 16

CONDENSING BOILERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Floor Mounted, Fire-Tube, Condensing Boilers

1.2 RELATED SECTIONS

A. Division 03 – Cast-In-Place Concrete

B. Section 23 05 00 – Common Work Results for HVAC

C. Section 23 21 16 – Hydronic Piping Specialties

1.3 REFERENCES

A. CSA - Directory of Certified Appliances and Accessories

B. ANSI Z21.13 - Gas-Fired Low-Pressure Steam and Hot Water Boilers

C. ASME SEC 1 - Boiler and Pressure Vessel Codes - Rules for Construction of Heating Boilers

D. ASME SEC 8D - Boilers and Pressure Vessel Codes - Rules for Construction of Pressure Vessels

E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)

F. NFPA 54 (AGA Z223.1) - National Fuel Gas Code

G. NFPA 70 - National Electrical Code

1.4 SUBMITTALS FOR REVIEW (REFER TO SECTION 23 05 00)

A. Product Data: Provide data indicating general layout, dimensions, and size and location of water, gas, and vent connections, and electrical characteristics and connection requirements.

1.5 SUBMITTALS AT PROJECT CLOSEOUT (REFER TO SECTION 23 05 00)

A. Operation and Maintenance Data: Include manufacturer’s descriptive literature, operating instructions, cleaning procedures, replacement parts list, and maintenance and repair data.

1.6 REGULATORY REQUIREMENTS

A. Conform to applicable code for internal wiring of factory wired equipment.

B. Conform to ASME SEC 4 for boiler construction. Boilers shall be stamped with official ASME symbol.

C. All boiler safety controls shall comply with ASME CSD-1 Code requirements.

D. Entire boiler package including pressure vessel, painted steel jacket, insulation, burner, fuel train, hot water trim and combustion control system shall meet FM, UL, CSD-1, NFPA, and applicable State of Washington requirements.

1.7 DELIVERY, STORAGE, AND HANDLING (REFER TO SECTION 23 05 00)

A. Protect units before, during, and after installation from damage to casing by leaving factory shipping packaging in place until immediately prior to final acceptance.

1.8 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.

B. Limited one-year parts warranty.

C. Limited 10-year closed-system heat exchanger warranty.

D. Limited 20-year thermal shock warranty.

PART 2 - PRODUCTS

2.1 FLOOR MOUNTED, FORCED DRAFT, CONDENSING BOILERS

A. Manufacturers (Refer to Section 23 05 00):
1. Cleaverbrooks
2. Lochinvar
3. Raypak
4. Aerco

B. General Description

1. Each unit shall be firetube type complete with boiler fittings and automatic controls. The boiler, with all piping and wiring, shall be factory packaged. Each boiler shall be neatly finished, thoroughly tested and properly packaged for shipping. Boiler design and construction shall be in accordance with Section IV of the ASME Code for hot water heating boilers with a maximum working pressure of 125 psig. The boiler shall be CSA (formerly AGA/CGA) approved as an indirect or direct vent boiler and comply with ASME CSD-1 Code requirements.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.
4. ASHRAE/IES 90.1 Compliance: Boilers to have minimum efficiency in accordance with Table 6.8.1-6 and other requirements in Ch. 6 of ASHRAE/IES 90.1.
5. ASHRAE 90.2 Compliance: Boilers to have minimum efficiency in accordance with Ch. 6 of ASHRAE 90.2.

C. Combustion Chamber:
1. Construct combustion chamber of 316L stainless steel and fully surround the burner.
2. Provide fully welded heat exchanger construction utilizing 316L stainless steel for fire-tubes, tube sheets, combustion chamber, flue collector, and pressure vessel shell.
3. Provide combustion chamber suitable for sealed combustion, employing FeCrAloy knitted mesh burner, mounted in vertical orientation.
4. Provide burner capable of firing at both complete blue flame with maximum gas and air input, and firing infrared when gas and air are reduced.
5. Provide burner capable of firing at 100 percent of rated input when supplied with 4.0-inches wg natural gas inlet pressure.
6. Provide burner with combustion air blower to control fuel/air mixture throughout the entire range of modulation.
   a. Include operating cycle in which combustion air blower operates for a pre-purge period before burner ignition and a post-purge period after burner operation.
7. Provide blower suitable to infinitely vary its output in response to a Pulse Width Modulation (PWM) signal supplied directly from the modulating temperature controller, thereby electronically and precisely adjusting the volume of air and gas supplied for combustion.

D. Heat Exchangers:
1. Primary Heat Exchanger:
   a. Provide primary heat exchanger made in helically wound, multi-pass design that completely encircles combustion chamber.
   b. Provide heat exchanger that is removable from cabinet for replacement without removing entire boiler assembly from site.
   c. Provide stainless steel combustion chamber designed to have a trough located on bottom front and back section leading to the middle to ensure that condensation does not collect in the boiler.
   d. Provide boilers that are ASME-inspected, -stamped, and National Board registered for 160 maximum allowable working pressure and 210 degºF maximum allowable operating temperature, complete with a manufacturer's data report.

e. Provide primary heat exchanger composed of single-bank, vertical, multi-pass design that completely encloses combustion chamber. Orient tubes vertically and roll tubes into a powder-coated, ASME boiler-quality, carbon steel tube sheet.
f. Seal heat exchanger to 160 psig-rated, unlined, bronze headers with silicone O-rings.
g. Provide low water volume primary heat exchanger that is explosion-proof on the waterside.
h. Secure headers to tube sheet by stud bolts with flange nuts to permit inspection and maintenance without removal of external piping connections.
   1) Provide primary heat exchanger with accessible boiler drain valves with hose bibb ends, to drain the water section of the primary heat exchanger.

2. Secondary Heat Exchanger:
   a. Provide single-bank, multi-pass design secondary heat exchanger constructed of stainless steel, and bearing ASME U stamp.
   b. Provide boiler(s) capable of operating at inlet water temperatures as low as 50°deg F.
   c. Provide heat exchanger of fully welded construction, utilizing 316L stainless steel for fire-tubes, tube sheets, combustion chamber, flue collector, and pressure vessel shell.
   d. Boiler Water Connections: NPS 2 “, threaded, ANSI 304AL stainless steel.
   e. Provide heat exchanger that is ASME inspected and stamped and National Board registered for 160 psig maximum allowable working pressure and 210 degºF maximum allowable operating temperature, complete with a manufacturer's data report.
   f. Temperature and pressure gauge.
   g. Provide integral flue gas test port as part heat exchanger flue collector.
   h. Minimum Heat Exchanger Water Volume: 17.2 gal
   i. Provide primary heat exchanger designed for single-pass flue gas, vertically oriented fire-tube design with water surrounding the combustion chamber.
   j. Provide heat exchanger with fully welded construction, utilizing 316L stainless steel for fire-tubes, tube sheets, combustion chamber, flue collector, and pressure vessel shell.
   k. Boiler Water Connections: 3-inch flanged, 150 pound, ANSI 304AL stainless steel.
   l. Provide heat exchanger that is explosion-proof on the waterside.
   m. Provide heat exchanger that is ASME inspected and stamped and National Board registered for 160 psig maximum allowable working pressure and 210 degºF maximum allowable operating temperature, complete with a manufacturer's data report.
   n. Temperature and pressure gauge, factory-mounted.
   o. Provide heat exchanger with two lifting lugs welded to top of vessel, suitable for rigging unit during installation
   p. Provide integral flue gas test port as part heat exchanger flue collector.
   q. Exhaust Decoupler: Fiberglass composite material in a corrosion-resistant steel box.
   r. Burner: Natural gas, self-aspirating and self-venting after initial start.
3. Provide burner suitable for field fuel conversion between natural gas and propane without requiring additional components.In paragraph below, retain first option for standard boiler operating at nameplate capacity. Retain second option for high-altitude boiler that operates at derated capacity. Verify boiler ratings suitable for project altitude with boiler manufacturer.

a. Operating Altitude: Provide boiler suitable for operation at altitudes up to 5000 ft above sea level.
b. Blower: Centrifugal fan to operate only during start of each burner sequence.

4. Motors: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   a. Motor Sizes: Large enough so driven load will not require motor to operate in service factor range above 1.0.
   b. Gas Train: Combination gas valve with manual shutoff and pressure regulator.Retain first "Ignition" Paragraph below if Raypak XFIIRE or XVers L Series is selected as basis of design.
   c. Ignition: Hot-surface ignition with transformer and 100 percent main-valve shutoff with electronic flame supervision.

E. Casing:
1. Jacket: Sheet metal, with snap-in or interlocking closures.
2. Finish corrosion-resistant galvanized-steel jackets with baked-on epoxy powder coat, suitable for outdoor installation, applied prior to assembly for complete coverage.
3. Incorporate louvers in outer panels to divert air past heated surfaces.
4. Control Compartment Enclosure: NEMA 250, Type 1A.
5. Finish: Baked-enamel protective finish.
6. Insulation: Minimum 2-inch -thick, mineral-fiber insulation surrounding heat exchanger.
7. Combustion-Air Connection: Inlet duct collar and sheet metal closure over burner compartment.
8. Mufflers: Carbon-steel intake muffler and stainless steel exhaust.
9. Condensate Trap: Cast-iron body with stainless steel internal parts.

F. Capacities and Characteristics:
1. As scheduled.
2. Include devices sized to comply with ASME B31.9.

G. Aquastat Controllers: Operating and high limit with automatic reset.

H. Safety Relief Valve: ASME rated.

I. Pressure and Temperature Gauge: Minimum 3-1/2-inch (89-mm) -diameter, combination water-pressure and -temperature gauge.
1. Provide gauge range so normal operating range is about 50 percent of full scale reading.

J. High and low gas-pressure switches.

K. Alarm bell with silence switch.

L. Boiler Air Vent: Automatic

M. Drain Valve: Minimum NPS 3/4 (DN 20) hose-end gate valve.H. Drain Valve: Minimum NPS ¾ (DN 20) hose-end gate valve.Retain first option in “Aquastat Controllers” Paragraph below if using modulating or high-low firing sequence.

2.2 BOILER OPERATING CONTROLS

A. Provide each boiler with control system that includes:
   1. Ability to receive a 0 to 10 Vdc signal from facility Central Energy Management and Direct Digital Control System (EMCS) to adjust water temperature set point or control firing rate.
   2. Alarm contact for connection to EMCS.
   3. Modbus communications compatibility with up to 146 points of data available.

B. Provide each boiler with integrated modulating digital controller having three user-selectable modes, factory-mounted and wired.
   1. Include the following modes of operation:
      a. Mode 1: Hydronic, without indirect domestic hot water.

C. Provide system sensor and air temperature sensor shipped loose for field installation. Provide factory-installed inlet and outlet temperature sensors.

D. Provide control system capable of controlling up the system pump.

E. Refer to Section 230923 "Direct Digital Control (DDC) System for HVAC".

F. Provide boiler operating controls that include the following:
   1. Control transformer(s) with fuse protection, to implement requirements indicated. Provide transformer with 25 percent spare capacity.
   2. Set-Point Adjust: Provide for operating and alarm set points that are field adjustable.
   3. Operating Water-Level Control: Cycle feed water pump(s) to maintain water level within acceptable limits.
   4. Operating Water-Level Control: Operate feedwater pump(s) continuously and modulate boiler feed water control valve in response to water level, and rate of pressure change to maintain water level within acceptable limits.
   5. Low-Water Cutoff Switch: Provide float and electronic probe to prevent burner operation when water level is low. Provide cutoff switch with automatic-type reset.
   6. Auxiliary Low-Water Cutoff Switch: Provide float and electronic probe to prevent burner operation when water level is low. Provide cutoff switch with manual-type reset.
   7. Provide microprocessor-based control system.
   8. Accuracy: Maintain level setpoint plus or minus 0.01 inch (0.25 mm)
   9. Provide visual indication of level, alarms, and errors via alphanumeric display.
   10. Features:
      a. Continuous water-level indication.
      b. Low-water cutoff and alarm.
      c. High-water alarm.
      d. Low- and high-water level warning.
      e. Control of feed water pump.
      f. Control of modulating feed water control valve.
      g. Continuous monitoring of float operation.
      h. Column blowdown detection and reminder.
      i. Auxiliary low-water cutoff check.
      j. Automatic and manual cutoff reset.
      k. Alarm annunciation.

G. Operating Controls for Hot-Water Boilers:

1. Sequence of Operation: Indicated on Drawings.

H. Multiple Boiler Operation: Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.

I. Boiler Emergency Shutdown: Interlock with field-installed boiler emergency shutdown switch to shut down boiler when activated. Contractor to furnish break-glass-type switch with permanent nameplate titled "Boiler Emergency Shutdown" for field installation.

J. Burner Safety Controls: Provide controls to maintain safe operating conditions, and burner safety controls to limit burner operation. Provide factory-mounted audible alarm with silence switch on control panel to sound alarm for the following conditions:
1. High Temperature Cutoff: Provide automatic type reset control that stops burner if operating conditions rise above boiler design temperature.
2. Low-Water Level Cutoff Switch: Provide electronic probe that prevents burner operation on low water level. Provide cutoff switch with automatic-type reset.
3. Auxiliary Low-Water Level Cutoff Switch: Provide electronic probe that prevents burner operation on low-water level alarm limit. Provide cutoff switch with manual-type reset.

K. Burner Flame Safeguard Controls:
1. Provide microprocessor-based, solid-state control having sequence and flame-on visual indication, and fault code indications of flame safeguard trip functions.
2. Provide control with dynamic self-check logic.
3. Provide control with fixed operating sequence incapable of being manually altered, that includes start, prepurge, pilot and main fuel ignition run, and postpurge cycles.
4. Provide control with non-recycle logic that deenergizes burner and indicates the following trip functions:
   a. Pilot and main flame failure.
   b. High- and low-fire proving switch faults.
   c. Running interlocks open.
   d. False flame signal and fuel valve open.
5. Provide control having run/test switch to allow interruptions to sequence just after prepurge and during pilot ignition trial, and run cycles for adjustments to firing rate motor, damper linkages, and pilot flame for minimum turndown tests.

L. Combustion-Air Controls: Provide factory-equipped blower control to regulate burner fire in accordance with load demand.

M. Oxygen Trim Control:
1. Provide oxygen trim system to continuously monitor and display oxygen concentrations in boiler flue gas and adjust fuel and airflow to maintain an adjustable oxygen-level set point.
2. Provide system suitable to compensate for changes in ambient temperature, barometric pressure, humidity, and variations in fuel characteristics.
3. Provide oxygen sensor directly mounted to vent piping.
   a. Provide sensor with cable disconnect fitting.
4. Provide touchscreen interface with oxygen trim system controls to display flue gas oxygen concentration value in colors:
   a. Blue, when flue gas oxygen concentration is at set-point.
   b. Red, when flue gas oxygen concentration is deviating from set-point.

5. Provide touchscreen that allows operator to select from three different operating curves:
   a. Optimum.
   b. More Excess Air.
   c. Less Excess Air.
6. Display error messages on control touchscreen and illuminate error lights.
   a. Display current error conditions on boiler page.
   b. Display previous error conditions on boiler history log.
7. Provide control system with self-diagnostic functions, including:
   a. System status.
   b. External factor preventing system from performing control activities.

N. Building Automation System Interface: Factory-install hardware and software to enable system to monitor, control, and display boiler status and alarms.
   1. Hardwired I/O Points:
      a. Refer to the Control Diagrams.
   2. Communication Interface: Provide ASHRAE 135 (BACnet) communication interface to enable control system operator to remotely control on/off operation and capacity of boiler, and monitor the boiler operation from a remote operator workstation.
      a. Make control features and monitoring points at boiler-control panel available to control system through communication interface.

O. Integrated Boiler-Control System:
   1. Provide factory-preconfigured integral control system for burner management, flame safety, boiler modulation, and operator interface functions with features and functions indicated.
   2. Provide solid-state controls and sensors to execute various control functions, including the following:
      a. Automatic sequencing of the boiler through standby, prepurge, pilot flame establishing period, main flame establishing period, run, flame proving and lockout, and postpurge.
      b. Full modulating control of air and fuel through Proportional-Integral-Derivative (PID) algorithm.
      c. Thermal shock protection.
      d. High and low temperature limit alarms and shutdowns.
   3. Provide control system with fully integrated control of the following:
      a. Blower operation and combustion-air damper for varying operating conditions.
      b. Oxygen trim and monitoring to compensate for combustion-air variations.
      c. Parallel positioning for independent fuel and air control.
      d. Multiple boiler lead/lag control with hot standby for idle boiler(s).
      e. Draft control for maintaining proper and consistent draft.
   4. LAN/WAN interface with remote monitoring software to allow remote monitoring independent of control system interface.

P. Boiler Operating Controls:
   1. Provide modulating, digital temperature controller with 4.3-in. (109-mm) capacitive color touchscreen display, factory-mounted and wired.
   2. Provide modulating, digital temperature controller with 7.0-in. (178-mm) capacitive color touchscreen display mounted and wired on the unit.
   3. Include the following modes of operation:
      a. Mode 1: Hydronic, without indirect domestic hot water.

b. Provide three pump control relays.
c. Provide freeze protection logic that energizes boiler pump and opens boiler isolation valve when boiler water temperature is below 45 deg F .
d. Provide factory-mounted and -wired water temperature sensors at water inlet and outlet.
e. Furnish indirect temperature cascade temperature sensors for field installation.
f. Furnish remote outdoor air temperature sensor for field installation.

4. Provide water flow rate sensor, mounted, wired, and accurate to within one percent of full scale flow, which enables the following control sequence:
   a. When boiler operation is initiated, the boiler pump starts. When water flow rate sensor detects that flow has reached manufacturer's minimum boiler flow requirement, Platform Ignition Module (PIM) enables ignition.
      1) When minimum flow is achieved, boiler controls enables ignition controls to ignite burner and operate boiler in accordance with its programmed control sequence.
      2) If minimum flow rate has not been achieved within 90 seconds after the boiler start signal, controls to energize "Flow Error" alarm, and notify operator that ignition did not occur due to insufficient flow.
      3) Provide controls that allow operator to override Flow Error condition for up to 24 hours.
         a) Provide controls that limit combustion to 80 percent firing rate during manual override operations.
   b. Provide controller suitable for adjustable cascade flow offset function of a cascaded system, in which the master boiler controller will only allow the next unit in the cascade to operate when flow requirements are met.
   c. The boiler integrated control provides temperature differential (delta T) protection zones, which include a "Flow Warning Zone," which broadcasts an alarm when delta T is higher than expected for current flow rate and firing rate.
      1) Controls to maintain boiler in "Hold Firing Rate Zone," where firing rate is held constant to prevent increasing delta T.
      2) Controls to maintain "Minimum Firing Rate Zone," where the firing rate will drop to its minimum rate to prevent a delta T fault.
   d. Display flow rate in gpm and make flow rate value available via controller DDC data port.
5. Include glycol percentage user setting to automatically and dynamically adjust maximum allowable firing rate, maximum temperature differential, minimum required liquid flow, and burner response timing.
6. Include vent material selection setting, which along with a flue gas temperature sensor, dynamically adjusts firing rate to provide protection for the vent system engineered for Project.
7. Include built-in "Cascade" function for up to eight units of same or different BTUH inputs, without utilizing external controller or sequencer.
   a. Include selectable modes for parallel modulation and sequential modulation with lead boiler rotation and lead-lag operation.
   b. Capable of leader redundancy and lead rotation every 48 hours.
   c. Allow operators to enable or disable alarm sharing across cascaded appliances when an alarm condition occurs. Include built-in "Cascade" function to sequence and rotate while maintaining modulation of up to four boilers without utilizing an external sequencer.
8. Document viewer included in touchscreen with supporting documents loaded into memory at time of shipment.

9. Firing Mode: Provides electronic modulating control of the gas input to the boiler.
10. Boiler Diagnostics - Provide external visible LED panel displaying the following boiler status/faults:
    a. Power on: Green.
    b. Call for heat: Amber.
    c. Burner firing: Blue.
    d. Service: Red.
11. Monitoring of all safeties, internal/external interlocks with fault display on the touchscreen display:
    a. System status.
    b. Condensate blockage.
    c. Manual-reset high limit.
    d. Low water cutoff.
    e. Blocked vent.
    f. Controller alarm.
    g. Flow switch, if provided.
    h. Factory option.
    i. External interlock.
    j. Ignition lock-out.
    k. Blower speed error.
    l. Low 24V ac secondary power.
    m. Sensor Failure.
        1) Inlet temperature sensor, open or short.
        2) Outlet temperature sensor, open or short.
        3) System (cascade) sensor, open or short.
        4) Outdoor air temperature sensor, open or short.
        5) Temperature to indirect sensor, open or short.
        6) Indirect domestic hot water tank temperature sensor, open or short.
        7) Water flow rate sensor.
        8) Vent temperature sensor.
        9) Internal control fault.
        10) ID card fault.
        11) Cascade communication error.
        12) Auto-reset high temperature limit.
        13) Low gas pressure switch.
        14) High gas pressure switch.
    n. Safety Controls:
        1) High temperature limit control with manual reset, factory-mounted and wired.
        2) Flow switch, factory-mounted and wired.
        3) Low water level cut-off with manual reset, factory-mounted and wired.
        4) Blocked vent pressure switch, factory-mounted and wired.
        5) Blocked condensate level switch, factory-mounted and wired.
        6) Adjustable high temperature limit control with manual reset, mounted and wired.
        7) Adjustable high temperature limit control with auto reset, mounted and wired.

Q. Control Connectivity:
    1. Provide boiler control system including connectivity feature that allows remote access to water heater data, and to transmit maintenance reminders and error notifications to iOS and Android devices, or by website access.

2. Provide system that allows for registration of multiple devices installed at various locations, and multiple devices in a single cascade installation. Include the following features:
   a. System that allows separate Groups to be established, with various levels of access and control permission to be set by equipment owner.
   b. "Groups" feature, to allow for quick and efficient troubleshooting service by heater manufacturer's service team.
   c. Send reminders and alert notification via text message or email to iOS or Android devices. Allow users to configure notification features.
3. Allow remote monitoring of the following via Raymote application and website:
   a. Outlet and inlet temperature monitoring.
   b. Vent temperature.
   c. Flow rate, if included in Project design.
   d. Blower speed.
   e. Modulation percentage.
   f. Flame current.
   g. Run time.
   h. Boiler Status.
   i. Cycles.
   j. Historical data.
4. Allow remote control and adjustment of the following:
   a. Temperature set point.
   b. Temperature differential.
   c. Outdoor air temperature reset settings.
   d. Indirect setpoint.
   e. Indirect differential temperature.
   f. Make full historical operating data reports available for review on the Raymote website.
   g. Indirect differential temperature.
   h. Custom notification.
   i. Make full historical data reports available for review on the Raymote website.

2.3 ELECTRICAL POWER

A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are indicated on Drawings and specified in electrical Sections.

B. Single-Point Field Power Connection: Provide factory-installed and -wired switches, motor controllers, transformers, and other necessary electrical devices designed for single-point field power connection to boiler.
   1. House in NEMA 250, Type 1 enclosure.
   2. Number and color-code wiring to match wiring diagram.
   3. Install factory wiring outside of an enclosure in metal raceway.
   4. Field Power Interface: Refer to the Electrical Drawings.
   5. Provide branch power circuit to each motor and to controls with a disconnect switch or circuit breaker.
   6. Provide each motor with overcurrent protection.

2.4 VENTING KITS

A. Kit: Complete system, ASTM A959, Type 29-4C stainless steel pipe, vent terminal, thimble, indoor plate, vent adapter, condensate trap and dilution tank, and sealant.

B. Combustion-Air Intake: Complete system, stainless steel pipe, vent terminal with screen, inlet air coupling, and sealant.

2.5 CONDENSATE-NEUTRALIZATION UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. JJM Alkaline Technologies.
   2. Neutra-Safe Corporation.
   3. SFA Saniflo USA.
   4. Skidmore Pump.
   5. Wessels Company.

B. Description: Factory-fabricated and -assembled condensate-neutralizing capsule assembly of corrosion-resistant plastic material with threaded or flanged inlet and outlet pipe connections. Device functions to prevent acidic condensate from damaging grain system. It is to be piped to receive acidic condensate discharged from condensing boiler and neutralize it by chemical reaction with replaceable neutralizing agent. Neutralized condensate is then piped to suitable drain.

C. Capsule Features:
   1. All corrosion-resistant material.
   2. Suitable for use on all natural gas and propane boilers.
   3. Includes initial charge of neutralizing agent.
   4. Neutralizing agent to be easily replaceable when exhausted.
   5. Inlet and outlet pipe connections.

D. Capsule Configuration:
   1. Low-profile design for applications where boiler condensate drain is close to the floor.
   2. Easily removed and opened for neutralizing agent replacement.
   3. Multiple units may be used for larger capacity.

E. Tank Configuration:
   1. Utilized where boiler is elevated or where tank is installed in a pit with tank top flush with floor.
   2. Top easily removed for neutralizing agent replacement.
   3. Internal baffles to channel flow for complete neutralization.
   4. Integral bypass to prevent condensate backflow into appliance.
   5. Multiple units may be used for larger capacity.

2.6 SOURCE QUALITY CONTROL

A. CSA Compliance: Test boilers for compliance with ANSI Z21.13-2017/CSA 4.9.

B. Performance Testing: Test and label boilers for efficiency to comply with AHRI 1500.

C. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.

D. Test and inspect factory-assembled boilers, before shipping, in accordance with ASME Boiler and Pressure Vessel Code. Factory test boilers for safety and functionality; fill boiler with water, and fire throughout firing range, to prove operation of all safety components.

E. Allow Owner access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide in accordance with manufacturer's instructions and as indicated on drawings.

B. Install in accordance with NFPA 54.

C. Install boiler on concrete housekeeping base, sized minimum 6 inches larger than boiler base. Housekeeping pad not in Division 23. Furnish shop drawings and other required information in order to coordinate required size of housekeeping pads.

D. Provide connection of natural gas service in accordance with NFPA 54 (AGA Z223.1) and NFPA 31.

E. Provide piping connections and accessories as indicated. (Refer to Section 23 21 23)

F. Pipe relief valves to nearest floor drain/glycol tank.

G. Provide all required boiler control wiring, low water cutoff and alarm wiring.

H. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of equipment connection. Provide a reducer if required.

I. Connect hot-water piping to supply and return boiler tappings with shutoff valve and union or flange at each connection.

J. Boiler Venting:
   1. Install flue venting kit and combustion-air intake.
   2. Connect full size to boiler connections. Comply with requirements in Division 23 Section 23 51 00.

K. Provide for connection to electrical service. Refer to Division 26.

L. Install control wiring to field mounted electrical devices.

3.2 MANUFACTURER'S FIELD SERVICES

A. Prepare and start systems under provisions of Section 23 05 00.

B. Instruct operating personnel in operation and maintenance of units.

C. Startup and testing shall be accomplished by a factory trained technician. Service technician performing startup shall provide a report of startup and test results for O & M Manual (Refer to Section 23 05 00).

D. Testing shall include written reports on boiler firing rate, turndown efficiency, O2, CO, and NO_X levels, flue gas temperature, ambient temperature, and all control settings.

3.3 SCHEDULES

A. See schedule on drawings for model numbers, capacities, and additional information.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing and training.
      a. Service representative shall have factory training on specific equipment furnished in this project and shall provide certificate from manufacturer of approval and training dates

B. Tests and Inspections:
   1. Perform installation and startup checks according to manufacturer's written instructions. Complete startup form included with Boiler and return to Manufacturer as described in the instructions.
   2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
   3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
      a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
      b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

D. Performance Tests:
   1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.

2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
3. Perform field performance tests to determine capacity and efficiency of boilers.
4. Repeat tests until results comply with requirements indicated.
5. Provide analysis equipment required to determine performance.
6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
7. Notify Architect and Commissioning Agent in advance of test dates.
8. Perform a combustion analysis after installation and adjust gas valve per the Installation and Operations manual and note in startup report.
9. Document test results in a report and submit to Architect.
10. Provide certified combustion analyzer “tapes” for the lowest published firing rate and full fire.

3.5 DEMONSTRATION

A. Engage a factory representative or a factory-authorized service representative for boiler startup and to train Owner's maintenance personnel to adjust, operate, and maintain boilers.

END OF SECTION

SECTION 23 55 05

FUEL FIRED UNIT HEATERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Gas fired unit heaters (separated combustion, centrifugal fan)

1.2 RELATED SECTIONS

A. Section 23 05 00 – Common Work Results for HVAC

B. Section 23 05 13 – Common Motor Requirements for HVAC Equipment

C. Section 23 05 48 – Vibration Isolation

D. Section 23 09 23 – Direct-Digital Control for HVAC

E. Section 23 51 00 – Breechings, Chimneys, and Stacks

1.3 SUBMITTALS FOR REVIEW

A. Submit under provisions of Section 23 05 00.

B. Product Data: Provide manufacturer's literature and data indicating rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.

C. Shop Drawings: Indicate assembly, required clearances, and locations and sizes of field connections.

D. Manufacturer venting and combustion air details, installation requirements and terminations.

1.4 OPERATION AND MAINTENANCE DATA (REFER TO SECTION 23 05 00)

A. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listing.

1.5 REGULATORY REQUIREMENTS

A. Products Requiring Electrical Connection: UL listed and classified as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 GAS FIRED UNIT HEATERS (SEPARATED COMBUSTION, CENTRIFUGAL FAN)

A. Manufacturers (Refer to Section 23 05 00):
1. Trane
2. Modine
3. Reznor

B. Units: Self-contained, packaged, factory assembled, AGA Certified, pre-wired unit consisting of cabinet, supply fan, heat exchanger, burner, controls, and accessories:
1. Heating: Natural gas fired
2. Discharge Louvers: Individually adjustable horizontal and vertical louvers with stops.
3. Cabinet: 20 gauge galvanized steel with baked enamel finish, glass fiber interior insulation and reflective liner, thread hanger connection for suspension hanging and safety fan guard.

C. Supply Fan: Centrifugal type, belt driven with adjustable pitch motor sheave, internal overload protection.

D. Heat Exchanger: Aluminized steel Type 409 stainless steel heat exchanger, aluminized steel Type 409 stainless steel burner with stainless steel insert.

E. Flue Vent Fan: Provides power venting. Factory assembled to a sealed flue collection chamber.

F. Gas Burner:
1. Flue vent fan relay
2. Combustion air pressure switch
3. Two stage gas control
4. Redundant 24 V gas valve with 100 % safety shut-off
5. High limit control
6. Intermittent spark pilot with electronic flame supervision
7. All required limit and safety controls

G. Operating Controls
1. Room Thermostat: Cycles burner to maintain room temperature setting.
2. Supply Fan Control: Energize from bonnet temperature independent of burner controls, with adjustable timed delay and fixed timed on delay, with manual switch for continuous fan operation.

H. Vent
1. Provide venting in accordance with Section 23 51 00. Venting and combustion air intake shall be separated.

I. Performance: Refer to schedule on the drawings.

J. Electrical Characteristics
1. Refer to drawings for motor characteristics.
2. 24 Volt transformer
3. Factory supplied terminal board for connection to thermostat.

4. Single point electrical connection, factory wired.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's recommendations and as detailed on the drawings.

B. Install unit heaters with vibration isolation. Refer to Section 23 05 48 for vibration and seismic controls.

C. Furnish controls to Section 23 09 23 for installation.

D. Install vents in complete accordance with manufacturer requirements.

END OF SECTION

SECTION 23 73 00

CENTRAL STATION AIR HANDLING UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Packaged Roof Top Semi-Custom Air Handling Units with Heat Pump and Gas Heat

1.2 RELATED SECTIONS

A. Section 23 05 00 – Common Work Results for HVAC

B. Section 23 05 13 – Common Motor Requirements for HVAC Equipment

C. Section 23 05 48 – Vibration Isolation

D. Section 23 05 93 – Testing, Adjusting, and Balancing

E. Section 23 09 23 – Direct-Digital Control for HVAC

F. Section 23 09 95 – Variable Frequency Drives

G. Section 23 40 00 – Air Cleaning Devices

1.3 REFERENCES

A. ANSI/AFBMA9 - Load Ratings and Fatigue Life for Ball Bearings

B. ABMA STD 11 - Load Ratings and Fatigue Life for Roller Bearings

C. AMCA 99 - Standards Handbook

D. AMCA 210 - Laboratory Methods of Testing Fans for Rating

E. AMCA 300 - Test code for Sound Rating Air Moving Devices

F. AMCA 301 - Methods of Publishing Sound Ratings for Air Moving Devices

G. AMCA 500 - Test Methods for Louvers, Dampers and Shutters

H. ARI 410 - Standard for Forced-Circulation Air-Cooling and Air-Heating Coils

I. ARI 435 - Standard for Application of Central-Station Air-Handling Units

J. NEMA MG1 - Motors and Generators

K. NFPA 70 - National Electrical Code

L. UL 1995 - Standard for Safety - Heating and Cooling Equipment

M. UL 508 - Standard for Industrial Control Panels

1.4 SUBMITTALS FOR REVIEW (REFER TO SECTION 23 05 00)

A. General
1. Statement of Conformance: The air handling unit submittal shall be accompanied by a statement of conformance by the air handling unit supplier. This statement of conformance shall indicate that the air handling units, as installed, will meet all of the requirements of these specifications. If the air handling units will not meet each requirement of these specifications, this statement of compliance shall indicate each individual requirement that cannot be met, the impact this might have on the system, and the proposed method of equivalent compliance.
2. Testing: Provide testing procedures to be performed in accordance with these specifications. When field testing is required, provide the name of the testing agency(ies) to be utilized.
3. Indicate weights, fan performance, coil capacities, ratings, gages and finishes of materials, and electrical characteristics and connection requirements.
4. Dimensioned plan and elevation view drawings and location of all field duct connections and openings.
5. Filters: Data for filter media, filter performance data, filter assembly, and filter frames.
6. Unit Manufacturer shall provide certified ratings conforming to the latest edition of AMCA 210, 300, 500, and AHRI 410.
7. Construction: Detail side and roof panel, base, floor, and filter rack construction as well as finish.
8. Access Doors: Indicate construction, method of sealing, and safety lockout features. Indicate doors to be provided with safety lockouts and direction of swing of each door.
9. Control Dampers: Detail damper construction including blade type and frame, blade, and seal material. Provide leakage data.
10. Factory Installed Components: Indicate factory installation of actuators as required.
11. The equipment Manufacturer shall furnish calculations showing the estimated sound power levels at the supply air connection, return air connection, outside air opening, relief air openings, as well as unit casing radiation for each air conditioning unit. Sound power levels shall be determined for each octave band and shall not exceed the following. See schedule on drawings for Basis of Design.

B. Electrical
1. Indicate motor sizes and electrical characteristics.
2. Lights/Wiring: Indicate number, location, and type of lights as well as conduit and wire routing and point of connection. Clearly indicate factory installed and field installed wiring.

C. Fans
1. Construction: Indicate type, material, blade type, class, shaft material and type of attachment to wheel and sheaves, base construction, safety screen and belt guard construction, seismic and fan thrust restraint and vibration isolation provisions. Detail flow measurement station when required.

2. Performance Information: Provide all information indicated in the equipment schedule. Performance shall be based on the design external static pressure plus the internal static pressure of the unit as submitted for the design airflow. For units with fan array provide fan performance for all fans operating and one fan failed.
3. Fan Curves: Provide certified fan curves for each fan with design flow and pressure plotted. Curves shall be provided on a chart with flow on the x-axis and pressure on the y-axis. Brake horsepower shall be indicated on the chart sufficient to determine the brake horsepower at any given point on the curve.

D. Coils
1. Construction: Indicate casing, tube, fin, header, and rack construction, including tube diameter and fin spacing. Indicate coils are fully drainable and show vents and drains (excluding refrigerant coils).
2. Performance Information: Provide all information indicated in the equipment schedule.

E. Condensate Drain Pans: Indicate material, double-sloped construction, fully drainable nature, pitch of slope, location and coverage, and drain connection size and location.

F. Submit the manufacturer's installation manual & equipment specific startup documents as a part of the initial equipment submittal.

G. Submit the manufacturer's operating and maintenance manual as a part of the initial equipment submittal.

1.5 OPERATION AND MAINTENANCE MATERIALS (REFER TO SECTION 23 05 00)

A. Provide the following minimum information: Fan and coil performance; fan curve information (for fan array provide fan performance for all fans operating and one fan failed); lubrication instructions including lubrication points, type of lubrication to be provided, and frequency of lubrication; instructions for filter, motor and drive replacement; wiring diagrams; customized spare parts list for each air handling unit with unit tag #, serial #, OEM part #/description for motor, coil, filters, filter gauges, bearings, drives, sheaves, fan shaft, belts and other commodity components.

1.6 REGULATORY REQUIREMENTS

A. Air handling units shall be designed and manufactured in strict accordance with UL 1995 Standard for Air Handling Equipment. Air handling unit shall be ETL of UL listed in accordance with UL 1995, and shall bear the ETL or UL label. If the manufacturer cannot provide an ETL/UL sticker on the air handling equipment, it shall be the sole responsibility of the contractor to arrange for local, on-site, ETL or UL approval and labeling.

B. Air handling units with factory wiring shall be factory UL or ETL approved and labeled. If the manufacturer cannot provide an ETL/UL sticker on the air handling equipment, it shall be the sole responsibility of the contractor to arrange for local, on-site, ETL or UL approval and labeling.

C. Air handling units with electrical panels shall be built in strict accordance to NEC standards and shall bear an appropriate label certifying compliance with UL Standard 508A.

D. Fan performance ratings shall be AMCA certified in accordance with AMCA 210. Fans shall bear the AMCA sticker.

E. Sound ratings shall be AMCA certified in accordance with AMCA 300.

F. Coil capacities, pressure drops, and selection procedures shall be ARI certified in accordance with ARI 410.

G. Fabrication shall conform to AMCA 99 and ARI 435.

1.7 QUALITY ASSURANCE/QUALIFICATIONS

A. The air handling unit manufacturer shall provide single source responsibility for all components of the unit whether specifically manufactured by the unit manufacturer or obtained outside and installed in the equipment.

B. Air handling units and major components shall be products of manufacturing firms regularly engaged in production of such equipment whose products have been in satisfactory use in similar service for not less than ten (10) years.

C. Units shall be constructed for stable operation (without excessive vibration and surging) with inlet and outlet plenums engineered by the manufacturer. The manufacturer shall consider the duct connection locations as well as the external ductwork and associated velocities that attach to the unit.

D. The air handling unit shall be shipped to the job site in one piece.
   1. Exceptions:
      a. Air handling units too large to be legally shipped by truck may be shipped to the site in sections.
      b. Air handling units may be shipped in sections at the contractor’s option with written approval from the engineer.

E. If Manufacturer cannot provide any of the items or options listed within this specification it must be noted as an exception on the bid.

1.8 EFFICIENCY STANDARDS

A. Units that require a 10 % or greater increase in fan brake horsepower than the scheduled equipment to meet the design flow and external static pressure requirements will not be considered equal and will not be accepted.

1.9 SOUND CRITERIA

A. Sound: The manufacturer shall furnish sound power levels at the supply air connection, return air connection, outside air opening, relief air openings and casing radiation for

each unit. Test data shall show sound power levels reference 10 to 12 watts for each of eight (8) octave band center frequencies. Sound levels may be derived from factory testing or engineered based upon unit construction and components selected at design conditions.

1.10 DELIVERY, STORAGE, AND HANDLING (REFER TO SECTION 23 05 00)

A. Deliver, store and handle in accordance with the manufacturer's requirements.

B. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.

C. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

D. Do not allow unit internal insulation to become wet.

1.11 ENVIRONMENTAL REQUIREMENTS

A. Do not operate units until both the space and ductwork are clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.12 EXTRA MATERIALS (REFER TO SECTION 23 05 00)

A. Fan bearings – One (1) for each different size and/or type of bearing

1.13 DRAWING SCHEDULES

A. Refer to equipment schedules on drawings for additional information.

PART 2 - PRODUCTS

2.1 PACKAGED, ROOFTOP, SEMI-CUSTOM AIR HANDLING UNITS WITH DX HEAT PUMP AND GAS FIRED HEATING:

A. Manufacturers (refer to Section 23 05 00)
1. York
2. Daikin
3. Aaon

B. Configuration: Fabricate as detailed on prints and drawings:
1. Return plenum / economizer section
2. Filter section
3. Cooling coil section
4. Supply fan section
5. Gas heating section.

6. Condensing unit section

C. The complete unit shall be cETLus listed.

D. The unit shall be ASHRAE 90.1-2016 compliant and labeled.

E. Each unit shall be specifically designed for outdoor rooftop application and include a weatherproof cabinet.

F. Each unit shall be completely factory assembled and shipped in one piece. Packaged units shall be shipped fully charged with R-410 Refrigerant and oil.

G. The unit shall undergo a complete factory run test prior to shipment. The factory test shall include a refrigeration circuit run test, a unit control system operations checkout, a unit refrigerant leak test and a final unit inspection.

H. All units shall have decals and tags to indicate caution areas and aid unit service. Unit nameplates shall be fixed to the main control panel door. Electrical wiring diagrams shall be attached to the control panels. Installation, operating and maintenance bulletins and start-up forms shall be supplied with each unit.

I. Performance: All scheduled EER, IEER, capacities and face areas are minimum accepted values. All scheduled amps, kW, and HP are maximum accepted values that allow scheduled capacity to be met.

J. Cabinet, Casing, and Frame

1. Panel construction shall be double-wall construction for all panels. All floor panels shall have a solid galvanized steel inner liner on the air stream side of the unit to protect insulation during service and maintenance. Insulation shall be a minimum of 2" thick with an R-value of 13.0, and shall be 2 part injected foam. Panel design shall include no exposed insulation edges. Unit cabinet shall be designed to operate at total static pressures up to 5.0 inches w.g.
2. Exterior surfaces shall be constructed of painted galvanized steel, for aesthetics and long-term durability. Paint finish will include a base primer with a high-quality polyester resin topcoat. Finished, unabraded panel surfaces shall be exposed to an ASTM B117 salt spray environment and exhibit no visible red rust at a minimum of 3,000 hours exposure. Finished, abraded surfaces shall be tested per ASTM D1654, having a mean scribe creepage not exceeding 1/16” at 1,000 hours minimum exposure to an ASTM B117 salt spray environment. Measurements of results shall be quantified using ASTM D1654 in conjunction with ASTM D610 and ASTM D714 to evaluate blister and rust ratings.
3. Service doors shall be provided on the fan section, filter section, control panel section, and heating vestibule in order to provide user access to unit components. All service access doors shall be mounted on multiple, stainless steel hinges and shall be secured by a latch system. Removable service panels secured by multiple mechanical fasteners are not acceptable.
4. The unit base shall overhang the roof curb for positive water runoff and shall seat on the roof curb gasket to provide a positive, weathertight seal. Lifting brackets shall be provided on the unit base to accept cable or chain hooks for rigging the equipment.

K. Outdoor/Return Air Section

1. Unit shall be provided with an outdoor air economizer section. The economizer section shall include outdoor, return, and exhaust air dampers. The economizer operation shall be fully integral to the mechanical cooling and allow up to 100% of mechanical cooling if needed to maintain the cooling discharge air temperature. The outdoor air hood shall be factory installed and constructed from galvanized steel finished with the same durable paint finish as the main unit. The hood shall include moisture eliminator filters to drain water away from the entering air stream. The outside and return air dampers shall be sized to handle 100% of the supply air volume. The dampers shall be parallel blade design. Damper blades shall be gasketed with side seals to provide an air leakage rate of 1.5 cfm / square foot of damper area at 1" differential pressure in according with testing defined in AMCA 500. A barometric exhaust damper shall be provided to exhaust air out of the back of the unit. A bird screen shall be provided to prevent infiltration of rain and foreign materials. Exhaust damper blades shall be lined with vinyl gasketing on contact edges. Control of the dampers shall be by a factory installed direct coupled actuator. Damper actuator shall be of the modulating, spring return type.
2. Provide factory installed and tested, outdoor air monitor that controls outdoor air +/- 15% accuracy down to 40 cfm per ton.

L. Exhaust Fan
1. Exhaust fan shall be a single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with aluminum fan blades that are continuously welded to the hub plate and end rim. The exhaust fan shall be a direct drive fan mounted to the motor shaft. Belts and sheaves are not acceptable due to the additional maintenance.
2. The fan motor shall be a totally enclosed EC motor that is speed controlled by the rooftop unit controller. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.
3. The unit DDC controller shall provide building static pressure control. The unit controller shall provide proportional control of the exhaust fans from 25% to 100% of the supply air fan designed airflow to maintain the adjustable building pressure setpoint. The field shall mount the required sensing tubing from the building to the factory mounted building static pressure sensor.

M. Cooling Coil
1. The indoor coil section shall be installed in a draw through configuration, upstream of the supply air fan. The coil section shall be complete with a factory piped cooling coil and an ASHRAE 62.1 compliant double sloped drain pan.
2. The direct expansion (DX) cooling coils shall be fabricated of seamless high efficiency copper tubing that is mechanically expanded into high efficiency aluminum plate fins. Coils shall be a multi-row, staggered tube design with a minimum of 3 rows. All cooling coils shall have an interlaced coil circuiting that keeps the full coil face active at all load conditions. All coils shall be factory leak tested with high pressure air under water.
3. The cooling coil shall have an electronic controlled expansion valve. The unit controller shall control the expansion valve to maintain liquid subcooling and the superheat of the refrigerant system.
4. The refrigerant suction lines shall be fully insulated from the expansion valve to the compressors.

5. The drain pan shall be stainless steel and positively sloped. The slope of the drain pan shall be in two directions and comply with ASHRAE Standard 62.1. The drain pan shall have a minimum slope of 1/8" per foot to provide positive draining. The drain pan shall extend beyond the leaving side of the coil. The drain pan shall have a threaded drain connection extending through the unit base.

N. Supply Fan
1. Supply fan shall be a single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with fan blades that are continuously welded to the hub plate and end rim. The supply fan shall be a direct drive fan mounted to the motor shaft. Belts and sheaves are not acceptable due to the additonal maintenance.
2. All fan assemblies shall employ solid steel fan shafts. Heavy-duty pillow block type, self-aligning, grease lubricated ball bearings shall be used. Bearings shall be sized to provide a L-50 life at 250,000 hours. The entire fan assembly shall be isolated from the fan bulkhead with a flexible collar and mounted on 1” spring isolators.
3. All fan assemblies shall be statically and dynamically balanced at the factory, including a final trim balance, prior to shipment.
4. Supply fan and motor assembly combinations larger than 8 hp or 22” diameter shall be internally isolated on 1” deflection, spring isolators and include removable shipping tie downs.
5. The motor shall be T Frame and open drip proof. Overload protection and speed control is provided by the factory installed VFD and rooftop unit controller. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.
6. The supply fan shall be capable of airflow modulation from 30% to 100% of the scheduled designed airflow. The fan shall not operate in a state of surge at any point within the modulation range.

O. Heating Section
1. The rooftop unit shall include a natural gas heating section. The gas furnace design shall be one natural gas fired heating module factory installed downstream of the supply air fan in the heat section. The heating module shall be a tubular design with in-shot gas burners.
2. The module shall be complete with furnace controller and control valve capable of 12:1 modulating operation.
3. The heat exchanger tubes shall be constructed of stainless steel.
4. The module shall have an induced draft fan that will maintain a negative pressure in the heat exchanger tubes for the removal of the flue gases.
5. Each burner module shall have two flame roll-out safety protection switches and a high temperature limit switch that will shut the gas valve off upon detection of improper burner manifold operation. The induced draft fan shall have an airflow safety switch that will prevent the heating module from turning on in the event of no airflow in the flue chamber.
6. The factory-installed DDC unit control system shall control the gas heat module. Field installed heating modules shall require a field ETL certification. The manufacturer’s rooftop unit ETL certification shall cover the complete unit including the gas heating modules.

P. Heat Pump Heating

1. The evaporator coil, condenser coil, compressors and refrigerant circuit shall be designed for heatpump operation. The refrigerant circuit shall contain a 4 way reversing valve for the heatpump operation. The outdoor coil shall have an electronic expansion valve to control the refrigerant flow. The unit controller shall modulate the expansion valve to maintain compressor operation within the compressor operational envelope.
2. The refrigerant system shall have a pump-down cycle.
3. The unit shall have a natural gas furnace for hybrid heating. When the heat pump operation cannot maintain the discharge air temperature setpoint the natural gas furnace shall temper the airstream to the discharge air temperature setpoint.

Q. Condensing Section
1. Outdoor coils shall have seamless copper tubes, mechanically bonded into aluminum plate-type fins. The fins shall have full drawn collars to completely cover the tubes. A sub-cooling coil shall be an integral part of the main outdoor air coil. Each outdoor air coil shall be factory leak tested with high-pressure air under water.
2. Fan motors shall be an ECM type motor for proportional control. The unit controller shall proportionally control the speed of the condenser fan motors to maintain the head pressure of the refrigerant circuit from ambient condition of 0~120°F. Mechanical cooling shall be provided to 0º F. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase.
3. The condenser fan shall be low noise blade design. Fan blade design shall be a dynamic profile for low tip speed. Fan blade shall be of a composite materia
4. The unit shall have scroll compressors. One of the compressors shall be an inverter compressor providing proportional control. The unit controller shall control the speed of the compressor to maintain the discharge air temperature. The inverter compressor shall have a separate oil pump and low oil safety protection.
5. Pressure transducers shall be provided for the suction pressure and head pressure. Temperature sensor shall be provided for the suction temperature and the refrigerant discharge temperature of the compressors. All of the above devices shall be an input to the unit controller and the values be displayed at the unit controller.
6. Each circuit shall be dehydrated and factory charged with R-410A Refrigerant and oil.

R. Electrical
1. Unit wiring shall comply with NEC requirements and with all applicable UL standards. All electrical components shall be UL recognized where applicable. All wiring and electrical components provided with the unit shall be number and color-coded and labeled according to the electrical diagram provided for easy identification. The unit shall be provided with a factory wired weatherproof control panel. Unit shall have a single point power terminal block for main power connection. A terminal board shall be provided for low voltage control wiring. Branch short circuit protection, 115-volt control circuit transformer and fuse, system switches, and a high temperature sensor shall also be provided with the unit. Each compressor and condenser fan motor shall be furnished with contactors and inherent thermal overload protection. Supply fan motors shall have contactors and external overload protection. Knockouts shall be provided in the bottom of the main control panels for field wiring entrance.
2. An optional fused disconnect and 65,000 amp SCCR capability shall be provided.

S. Controls
1. Provide a microprocessor based system to control all refrigeration functions including compressor speed, condenser fan function, unit safety protection, including compressor minimum run and minimum off times, and diagnostics. This system shall operate the unit at peak efficiency utilizing variable head pressure control and electronic expansion valve while maintaining the cooling, or heating in heat pump operation, call per third party control. The microprocessor control shall consist of only direct expansion required temperature sensors, pressure sensors, controller and keypad/display operator interface. Refrigeration sensors and controller shall be factory mounted, wired and tested.
2. The microprocessor controls shall be solely dependent on communications with any on-site or remote PC or master control panel for proper unit operation. The microprocessor memory shall be protected from voltage fluctuations as well as any extended power failures. No commissioning settings shall be lost, even during extended power shutdowns
3. The microprocessor controls shall be dependent on starting and stopping of the unit via terminal strip control and logic. The control system shall be capable of providing a remote alarm indication. The microprocessor show provide compressor capacity & status, defrost status (heat pump only), condensate overflow alarm, and dirty filter alarm.
4. All digital and analog inputs and outputs shall be protected against damage from transients or incorrect voltages. All field wiring shall be terminated at a separate, clearly marked terminal strip.
5. The keypad interface shall allow convenient navigation and access to the commissioning functions. The unit keypad/display character format shall be 4 lines x 20 characters. All control settings shall be password protected against unauthorized changes. For ease of service, the display format shall be English language readout. Coded formats with look-up tables will not be accepted. The user interaction with the display shall provide the following information as a minimum:
   a. Supply and exhaust fan speed control.
   b. Refrigeration alarm details.

T. Roof Curb
1. See Section 23 05 48 for vibration isolated curb requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide air handling units in accordance with the manufacturer's instructions and as indicated on the drawings.

B. Provide vibration isolation and seismic controls in accordance with 23 05 48.

C. Provide vibration isolation and seismic controls in accordance with Section 23 05 48 and 23 05 49.
1. Provide neoprene flexible duct connections at each duct connection.
2. Air handling units shall be bolted to floor with neoprene pads between unit rail base and floor in accordance with Section 23 05 48. Bolts shall utilize neoprene washers for sound isolation.

D. Make all duct and piping connections to units as indicated on the drawings.

E. Pipe all condensate connections line-sized as indicated on plans and in accordance with the manufacturer requirements. Provide trap of sufficient depth to prevent air bypass.

F. Piping connections to coils shall be made with unions or flanges.

G. Install piping and ductwork to allow proper access to unit access doors and to facilitate coil removal.

3.2 MANUFACTURER'S FIELD SERVICES

A. Provide the service of a factory qualified technician to conduct factory authorized start-up and O&M training in maintenance and operation of unit. Include hands-on demonstration as part of the training session.

B. Technician shall be factory trained on this type of equipment. Submit certificates and training dates.

END OF SECTION

SECTION 23 81 03

PACKAGED VENTILATION AIR HANDLING UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Grade Mounted, Packaged Make-Up Air Heat Pump Units with DX Heat Pump and Gas Fired Heating
   1. Outdoor slab mounted, electronically controlled, cooling/heating unit utilizing hermetic scroll compressors with crankcase heaters for cooling duty and gas combustion heaters for heating duty. Units shall discharge supply air horizontally as shown on contract drawings.

1.2 RELATED SECTIONS

A. Section 23 05 00 – Common Work Results for HVAC

B. Section 23 05 13 – Common Motor Requirements for HVAC Equipment

C. Section 23 05 48 – Vibration Isolation

D. Section 23 09 23 – Direct-Digital Control for HVAC

E. Section 23 31 00 – HVAC Ducts and Casings

F. Section 23 33 00 – Air Duct Accessories

G. Section 23 40 00 – Air Cleaning Devices

1.3 REFERENCES

A. ARI 210 - Unitary Air -Conditioning Equipment.

B. ARI 270 - Sound Rating of Outdoor Unitary Equipment.

C. NFPA 70 - National Electrical Code.

D. NFPA 90A - Installation of Air Conditioning and Ventilation Systems.

1.4 SUBMITTALS FOR REVIEW (REFER TO SECTION 23 05 00)

A. Shop Drawings: Indicate capacity and dimensions of manufactured products and assemblies required for this project. Indicate electrical service with electrical characteristics and connection requirements, and duct connections.

B. Product Data: Provide capacity and dimensions of manufactured products and assemblies required for this project. Indicate electrical service with electrical characteristics and connection requirements, and duct connections.

1.5 SUBMITTALS AT PROJECT CLOSEOUT (REFER TO SECTION 23 05 00)

A. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.

1.6 REGULATORY REQUIREMENTS

A. Products Requiring Electrical Connection:
1. Unit shall be manufactured in strict accordance with UL 1995, Standard for Heating and Cooling Equipment.
2. Unit shall carry ETL or UL label.

1.7 DELIVERY, STORAGE, AND PROTECTION

A. Section 23 05 00 - Product delivery, storage, and handling.

B. Accept products on-site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.

C. Handle carefully to avoid damage to components, enclosures, and finish.

D. Do not allow internal insulation to become wet.

E. Unit shall be stored and handled per the manufacturer's recommendations.

1.8 QUALITY ASSURANCE

A. Unit shall be designed to conform to the latest adopted editions of ANSI/ASHRAE 15, ASHRAE 62, and UL Standard 1995.

B. Unit shall be listed as a total package by ETL.

C. Gas heat equipped units shall be designed to conform to ANSI Standard Z21.47 (U.S.A.).

D. Insulation and adhesive shall meet NFPA 90A requirements for flame spread and smoke generation.

1.9 WARRANTY AND QUALITY CONTROL

A. An extended warranty 2nd-10th years for the gas heat exchanger, parts only, shall be included.

B. Quality Control – A Complete Functional & Sequential Factory Run Test in Every Mode: Cooling, De-humidification, Heating, Economizer, Heat Recovery Mode, Heat Pump, as Configured shall be performed with test results available. Factory trimmed refrigerant charge and matching nameplate, complete functional test of every input and output, as configured.

PART 2 - PRODUCTS

2.1 GRADE MOUNTED, PACKAGED MAKE-UP AIR HEAT PUMP UNITS WITH DX HEAT PUMP AND GAS FIRED HEATING

A. Manufacturers (Refer to Section 23 05 00):
1. Daikin
2. Valent
3. Addison (Basis of Design)

B. GENERAL:
1. The unit shall be a packaged factory assembled heating and/or cooling system. The unit shall include all factory wiring with a single point power connection, phase and voltage monitor, refrigerant piping and charge (R-410A), operating oil charge. Single refrigerant circuit or dual refrigerant circuits shall include a microprocessor-based control system. The unit shall, based on project requirements, include all special features necessary to provide fully conditioned ventilation air at neutral conditions to the building.

C. UNIT CABINET:
1. Double wall design, constructed of G-90 galvanized steel, bonderized primed on exterior and interior and pre-coated with a polyester pre-coat finish on exterior.
   a. 2.0-in. thick, closed cell polyisocyanurate foam insulation.
   b. Access doors and panels shall be double wall construction with 2.0-in. thick, closed cell polyisocyanurate foam insulation. Fastening screws shall be Magniguard coated for corrosion resistance.
   c. Base pans shall be galvanized steel insulated with closed cell foam insulation to provide a thermal barrier and seal against the roof curb. All openings through the base pan shall have upturned flanges at least 1.5 inches in height with sealed corners.
   d. Condensate pan shall be double sloped, single wall stainless steel with welded corners and insulated with 1-inch closed cell neoprene insulation.
   e. Base rail shall be 6” minimum structural steel.
2. Unit casing shall be capable of withstanding up to 2,500-hour salt spray exposure per ASTM B117.
3. Unit shall have insulated access doors, for easy access to the controls compartment and all other areas requiring servicing. Each door shall seal against a triple edge co-extruded EPDM gasket to help prevent air and water leakage and for ease and safety during servicing. Access doors shall include a thermal break. Access doors shall be equipped with stainless steel piano hinges and quarter turn, adjustable, lockable by tool, draw tight cam-action latches.
4. Unit shall have provisions in frame rails to facilitate overhead rigging.
5. Filters shall be accessible through a hinged access panel.
6. The outdoor air opening shall have a factory provided hood with bird screen.

D. Fans:
   1. Supply Fans:
      a. Direct-drive plenum fan(s) shall be provided and both axial and radial clearances must be equal to or greater than fan manufacturer's recommendations for full rated fan performance and efficiency. The inlet cone, impeller with backward curved or airfoil blades is manufactured of steel with a painted finish. Fan assembly shall be statically and dynamically balanced at the factory as a single rotating assembly to a quality level of G=2.5 in accordance with DIN ISO 1940-1. Provide ODP or TEFC premium efficiency motors with VFD. Fan motor assembly is rigid mounted for optimal performance.
      b. Rubber pad isolation mount
      c. ECM type assembly is base mounted and external rotor fan with backward curved blades of high-performance composite material. Fan assembly shall be statically and dynamically balanced at the factory as a single rotating assembly to a quality level of G=6.3 in accordance with DIN ISO 1940-1.
   2. Condenser Fan and motor fully assembled by manufacturer:
      a. Fans shall be external rotor direct driven axial fans with a minimum 5-1/2" powder coated spun venturi for high efficiency and low noise, with powder coated sickle shaped blades.
      b. The fan motor TEAO, totally enclosed air over, assembly shall be end mounted to a structurally powder coated rigid welded finger guard.
      c. Fans shall be VFD driven for controlling head pressure. Low ambient operation is 0°F.
      d. Fans shall discharge air vertically upward and the finger guard shall be powder coated.
      e. Fans shall be statically and dynamically balanced as an assembly to a quality level of G=6.3 in accordance with DIN ISO 1940-1.

E. Compressors:
   1. Fully hermetic, scroll type compressors with overload protection and short cycle protection with minimum on and off timers. Time delay relay 5 minute minimum ON run time for proper oil level and compressor operation
   2. Compressor shall be installed in an insulated compartment accessible through hinged access doors for sound mitigation. Exposed compressors must be applied with sound blankets for sound mitigation.
   3. Line voltage, low voltage operating controls, refrigerant circuit access points, refrigerant flow control devices and compressors shall be accessible from a single location behind stainless steel piano hinged access doors for ease of service.
   4. Compressors shall be mounted on rubber in shear isolators and refrigerant lines to include reaction torque loops.
   5. Reverse rotation protection shall be provided for all compressors and all 3 phase motors in the unit.
   6. Crankcase heaters shall only be activated during compressor off mode.
   7. Variable Capacity Compressor(s):
      a. On circuits up to eight (8) tons a digital compressor shall be available on the lead refrigeration circuit. The control system shall be capable of unloading the compressor in an unlimited number of steps for capacity control. For units without ALC DDC controllers a Digital Control Module (DCM) shall be included.
      b. On circuits from ten (10) tons and larger a variable capacity compressor with a variable speed drive shall be available on the lead refrigeration circuit. The control system shall be capable of unloading the compressor in an unlimited

number of steps for capacity control. Unit sizes 480 and larger have tandem type compressors. The lead compressor shall include a variable speed drive and staging control for remaining compressors for capacity control.

F. Refrigerant Components:
1. Unit shall be equipped with single refrigerant circuit or dual refrigerant circuits with each circuit containing:
   a. Solid core filter drier.
   b. Field adjustable externally equalized thermostatic expansion valve.
   c. Service access ports
2. Unit shall be equipped with VFD-controlled variable condenser fan speed operation for head pressure control to allow low ambient operation down to 0F.
   a. Unit shall be equipped with VFD-controlled variable condenser fan speed operation for head pressure control to allow low ambient operation down to 0F.

G. Coils:
1. Standard evaporator coil shall have enhanced surface aluminum sine wave fins mechanically bonded to seamless copper tubes. Evaporator coils shall be minimum six (6) row with intertwined circuiting. Stacked coils shall be intertwined circuiting for the full-face area to be active and prevent any stratified air temperatures from occurring.
2. Air Cooled Condensing Coil, Cooling only duty: microchannel floating microchannel condenser coil mounting design with rubber isolation and glide path for coil expansion and contraction. Rigid mounted microchannel condenser coils are not acceptable.
   a. Air Source Heat Pump duty: Standard air-over condenser coils shall have enhanced surface aluminum plate fins mechanically bonded to seamless internally grooved copper tubes with brazed tube joints.

H. Coil Options:
1. Air cooled units, flooded condenser for head pressure control for operation down to a low ambient of minus 20 F during cooling operation.
2. Liquid Subcooling Coil: The unit could be equipped with a factory-installed liquid sub-cooling coil on all circuits. The coil shall be located immediately downstream of the evaporator coil. Coil circuit(s) shall be switchable. Operation of sub-cooling coil shall increase the total cooling capacity and offer first stage of reheat. Refer to the equipment schedule for increase in capacity MBH and resultant improvement in EER.

I. Filter Selections:
1. Standard filter selection shall have filter racks for 2in thick MERV-8 pleated filters as standard.

J. Weather hoods
1. Provide weather hood on outside air intake, and relief air discharge of unit.
2. Both the intake and discharge shall have ¾" x ¾" bird screen installed on unit.

K. Controls and Safeties:
1. Microprocessor Controls:
   a. Shall include application logic to control unit in several standalone modes:
      1) Supply Fan control
      2) DX Cooling control

3) Heating control (DX Heat Pump and/or Electric/Gas)
4) Dehumidification
5) ERV/Desiccant wheel operation and bypass damper operation
6) Outdoor Damper control for Outdoor air economization/energy efficiency

b. Unit operation shall include terminal control for unit control
1) Supply Air Temperature
2) Supply Air Dewpoint/Relative Humidity
3) Zone Air Temperature
4) Zone Air Dewpoint/Relative Humidity
5) Airflow CFM, based on Duct Pressure or Air Monitoring
6) Can include a field-installed space temperature sensor for zone control
7) Shall support BACnet IP, BACnet Ethernet, BACnet MS/TP and BACnet ARCNET
8) Shall support Modbus RTU and Modbus TCP
9) Can provide a 5° F temperature difference between cooling and heating set points to meet ASHRAE 90.1, energy standard.
10) Shall include a color HMI touchscreen (Equipment Touch).
11) HMI shall include user access differentiation via passcodes.
12) Shall provide at least 28 configurable inputs and 16 configurable outputs for unit control
13) Can provide field configurable Input/Outputs via HMI
14) Shall provide and display a current alarm list and an alarm history list.
15) Compressor minimum run time (3 minutes) and minimum off time (5 minutes) shall be provided.
16) Shall have service run test capability
17) Shall support Hand/Off/Auto switches on controller inputs and outputs for troubleshooting.
18) Unit controls shall be in electrically isolated low voltage control section.

c. The unit's packaged microprocessor controls shall interface with the building automation system. Refer to the control diagrams for intent of operation. The packaged controller shall control all unit components, with the building automation system providing monitoring.

L. Commissioning and Interface:
1. The commissioning HMI shall be a color touchscreen with access to all available modes, applicable setpoints and statuses, unit networking information and the like.
a. Safeties:
1) Compressor lockout protection provided for either internal or external overload.
2) Low-pressure protection.
3) Freeze protection (evaporator coil).
4) High-pressure protection.
5) Loss of charge protection.
b. Supply-air sensor shall be located in the unit and shall be used for compressor stage control.
c. Unit shall be equipped with a supply fan status switch to protect the system in the event of a fan drive failure.
d. Induced draft heating section shall be provided with the following minimum protections:
1) High-temperature limit switch.
2) Differential pressure switch for proof of induced draft.

3) Flame rollout switch.
4) Flame proving controls.
5) Redundant style gas valve.

M. Operating Characteristics:
1. Unit shall be capable of operating upwards of 115° F. outdoor ambient air temperature per maximum load criteria of AHRI Standard 920 and AHRI Standard 340/360.
2. Unit with standard controls will operate in cooling down to an outdoor ambient temperature of 0 o F.
3. Units shall be equipped with an enthalpy control economizer with modulating outdoor and return air dampers.
4. Unit shall be provided with fan time delay to prevent cold air delivery (gas heat only).

N. Electrical Requirements:
1. All unit power wiring shall enter unit cabinet at a single location with a single power point connection.
2. Control panel shall incorporate “Touch-safe” design.
3. Phase/Voltage Monitor: A factory-installed over / under-voltage and phase loss sensor shall stop the unit whenever voltage exceeds allowable range, phases are out of sequence, or a phase is dropped. The unit will restart automatically within five minutes after the correct power is supplied. Display shall be capable of archiving and display of last four (4) faults modes.
4. Convenience Outlet: Shall be factory-installed and internally mounted with an externally accessible 115-v, 15-amp GFCI, female receptacle with hinged cover. The outlet shall require field-supplied 115-v power supply wiring. Factory-wired GFI with a step-down transformer and 15.0 Amp breaker is also available.
5. Unit panel shall carry 65 KA SCCR rating. Unit sub wiring including contactors and motor starter protector rated at a minimum of 65KA. Over current protection devices for VFD's and ECM blowers are upgraded to fuses per manufacturer’s specs to increase the rating to a minimum of 65k.

O. Motors:
1. Compressor motors shall be cooled by refrigerant gas passing through motor windings and shall have either internal line break thermal and current overload protection or external current overload modules with compressor temperature sensors.
2. All condenser fan motors shall be totally enclosed air-over (IP54) with permanently lubricated ball bearings, class F insulation and manual reset overload protection.
3. Standard indoor fan motors shall be open drip proof design. Optional totally enclosed fan-cooled motors are available.

P. Unit Accessories and Options:
1. Gas Heating:
   a. Gas heat shall be induced-draft combustion type with energy saving direct spark ignition systems and redundant main gas valves.
   b. The heat exchanger shall be of the tubular section type constructed of a minimum of 20-gauge type 409 stainless steel.
   c. Burners shall be of the in-shot type constructed of aluminum coated steel.
   d. All gas piping shall be clearly identified on the unit cabinet.
   e. Induced-Draft Fans:
      1) Shall be direct-driven, single inlet, forward- curved centrifugal type.

2) Shall be statically and dynamically balanced.
3) Shall be made from steel with a corrosion- resistant finish.

f. High-corrosion areas such as flue gas collection and exhaust areas shall be lined with corrosion resistant material.
g. The unit shall have factory-installed gas heat with modulation options:
1) Modulating control providing 20% to 100% burner modulation
h. Furnace shall be accessed by a tool type latched and hinged service door as required by ANSI.
1) Heat exchanger is warranted for ten (10) years on a pro-rated basis.

2. Dampers: Outside Air Damper
a. Factory mounted AMCA certified, low leakage airfoil control dampers. Frame shall be one-piece uniframe construction of 16 ga. (1.6) galvanized steel roll formed hat channel structurally equivalent to a minimum 13 ga. (2.4) frame. Blades shall be 14 ga. (2.0) equivalent galvanized steel, roll-formed airfoil type for low pressure drop and low noise generation. Bearings shall be 304 stainless steel, oil impregnated, and self-lubricating sleeve type with a 450 pound (204 kg) minimum radial crush load.. Damper shall be tested and licensed in accordance with AMCA 511 for Air Performance and Air Leakage. Damper widths from 12" to 60" (305 to 1524) wide shall not leak any greater than 3 cfm/sq.ft. at 1" w.g. (15.2 l/s-m2 at .25 kPa).

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer’s instructions.

B. Provide vibration isolation and seismic controls in accordance with Section 23 05 48.

C. Install in accordance with NFPA 90A.

D. Duct connections to units to allow for straight and smooth airflow.

E. Condensate drain lines shall be trapped and drained to grade.

3.2 MANUFACTURER’S FIELD SERVICES

A. Provide the service of a factory qualified technician to conduct factory authorized start-up and O&M training in maintenance and operation of unit. Include hands on demonstration as part of the training session.

B. Technician shall be factory trained on this type of equipment. Submit certificates and training dates.

END OF SECTION

SECTION 23 81 26

SPLIT SYSTEM AIR CONDITIONERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Concealed Ceiling Ducted Indoor Fan-Evaporator Units

B. Four Way Blow Cassette Indoor Fan-Evaporator Units

C. Outdoor Heat Pump Condensing Units

1.2 RELATED SECTIONS

A. Section 23 05 00 – Common Work Results for HVAC

B. Section 23 05 13 – Common Motor Requirements for HVAC Equipment

C. Section 23 05 48 – Vibration Isolation

D. Section 23 23 00 – Refrigerant Piping

1.3 REFERENCES

A. ARI 210/240 - Unitary Air-Conditioning and Air-Source Heat Pump Equipment

B. ARI 270 - Sound Rating of Outdoor Unitary Equipment

C. ARI 365 - Commercial and Industrial Unitary Air-Conditioning Condensing Units

D. ASHRAE 14 - Methods of Testing for Rating Positive Displacement Condensing Units

E. ASHRAE 15 - Safety Code for Mechanical Refrigeration

F. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)

G. NEMA MG1 - Motors and Generators

H. UL 207 - Refrigerant-Containing Components and Accessories, Non-Electrical

I. UL 303 - Refrigeration and Air-Conditioning Condensing, and Air-Source Heat Pump Equipment

1.4 SUBMITTALS FOR REVIEW

A. Submit under provisions of Section 23 05 00.

B. Product Data: Provide rated capacities, weights specialties and accessories, electrical nameplate data, and wiring diagrams. Performance ratings shall be matched with indoor equipment to ensure capacities are complementary.

1.5 SUBMITTALS AT PROJECT CLOSEOUT (REFER TO SECTION 23 05 00)

A. Operation and Maintenance Data: Include start-up instructions, maintenance instructions, parts lists, controls, and accessories.

1.6 REGULATORY REQUIREMENTS

A. Products Requiring Electrical Connection:
   1. Condensing Units shall be ETL or UL listed and shall carry the ETL or UL Label.

1.7 DELIVERY, STORAGE, AND PROTECTION

A. Section 23 05 00 - Product delivery, storage and handling

B. Accept products on-site in factory-fabricated protective containers. Inspect for damage.

C. Comply with manufacturer’s installation instructions for rigging, unloading, and transporting units.

D. Handle carefully to avoid damage to components, enclosures and finish. Protect coils.

1.8 EXTRA MATERIALS (REFER TO SECTION 23 05 00)

A. Provide complete change of lubricating oil.

1.9 STANDARD LIMITED WARRANTY

A. Products are installed that under normal use and maintenance for comfort cooling and conditioning applications such products will be free from defects in material and workmanship. This warranty applies to compressor and all parts and is limited in duration to ten (10) years starting from the ‘’installation date’’ which is one of the two dates below:
   1. The installation date is the date that the unit is originally commissioned, but no later than 18 months after the manufacture date noted on the unit’s rating plate.
   2. If the date the unit is originally commissioned cannot be verified, the installation date is three months after the manufacture date.

1.10 QUALITY ASSURANCE

A. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL), in accordance with ANSI/UL 1995/CAN/CSA-C22.2 No. 236-05 (R2009) – Heating and Cooling Equipment and bear the Listed Mark.

B. All wiring shall be in accordance with the National Electric Code (NEC)/Canadian Electrical Code (CEC).

C. The system will be produced in an ISO 9001 and ISO 14001 facility, which are standards set by the International Standard Organization (ISO). The system shall be factory tested for safety and function.

D. The outdoor unit will be factory charged with R-410A.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers (Refer to Section 23 05 00):
1. Daikin
2. Mitsubishi
3. Samsung

2.2 CONCEALED CEILING DUCTED INDOOR FAN-EVAPORATOR UNITS

A. General Requirements:
1. All indoor/evaporator units shall be factory assembled and tested DX-fan coil units, operable with refrigerant R-410a.
2. All units shall be completely factory assembled and tested, and shall be charged with dehydrated air prior to shipment from the factory.
3. All units shall be equipped with an electronic expansion valve controlled using a PID loop to automatically adjust the refrigerant flow rate through the unit.
4. All units shall be equipped with a programmed drying operation that dehumidifies while limiting changes in room temperature when used with remote controllers.
5. All units shall feature self-diagnostics, auto-restart functionality, 3-minute fused time delay, and a test run switch.
6. All refrigerant piping, both liquid and suction, shall be fully insulated from the outdoor unit.

B. Indoor Unit:
1. Unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, condensate drain pump, condensate safety shutoff and alarm, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch. The unit shall be equipment with automatically adjusting external static pressure logic that is selectable during commissioning. This adjusts the airflow based on the installed external static pressure.

2. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
3. Both refrigerant lines shall be insulated from the outdoor unit.
4. The indoor units shall be equipped with a return air thermistor.
5. The indoor unit will be separately powered with 208~230V/1-phase/60Hz.
6. The voltage range will be 253 volts maximum and 187 volts minimum.

C. Unit Cabinet:
1. The unit cabinet shall be constructed of heavy gauge galvanized steel.
2. The unit shall be internally insulated and shall be capable of installation in indoor environments up to 80% relative humidity without requiring additional field installed insulation.
3. The unit shall ship from the factory in a rear-return configuration and shall be field-convertible to a bottom-return configuration.
4. The unit shall be equipped with a return air thermistor.
5. The cabinet shall be constructed with sound absorbing foamed fiber-less closed cell polystyrene and polyethylene insulation.

D. Fan:
1. The fan shall be a direct-drive, brushless DC fan motor with (3) user-selectable fan speeds (H, M, L).
2. The unit shall be equipment with automatically adjusting external static pressure logic selectable during commissioning.
3. The unit shall be equipped with internal controls to allow the fan to automatically select the operating fan curve to deliver nominal airflow CFM (within +/- 10%) when the connected ductwork has been designed with a total external static within the range. This setting shall be accessible as a setting to be used during startup and commissioning of the system
4. The fan motor shall be capable of Auto fan speed control when the unit is connected to the Remote Control. The Auto fan speed control shall automatically adjust the unit's fan speed in response to the difference between the indoor unit's current set point and the current room temperature measurement. The Auto fan speed control shall utilize (5) fan speeds.
5. The fan motor shall be internally isolated using rubber grommets to reduce transmission of vibrations to the unit.
   a. The airflow rate shall be available in three settings.
   b. The fan motor shall be thermally protected.

E. Fan Blade
1. The fan blade shall be constructed of lightweight polymer.
2. The fan blade shall be statically and dynamically balanced to minimize vibration.

F. Coil:
1. Coils shall be of the direct expansion type, constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
3. The coil shall be 2 or 3 row cross fin copper evaporator coil with 18 fpi design, completely factory tested.
4. The refrigerant connections shall be flare connections.
5. Factory mounted thermistors shall be installed on the liquid and gas lines.

G. Condensate Drainage
1. The unit shall be equipped with a condensate drain pan under the coil.
2. The condensate drain outlet shall be of PVC construction and VP25 (1" ID, 1-1/4" OD).
3. The unit shall be equipped with a factory-integral condensate pump capable of 25-5/16" lift from the condensate drain outlet. The condensate pump shall be equipped with a float switch to automatically stop unit operation and provide a system error code in the event drain pan water level rises too high.

H. Electrical:
1. Provide a separate power supply connection of 208/230V, 1 phase, 60 hertz. The allowable voltage range shall be 187 to 253 volts.
2. Refer to the engineering data book for all other electrical data including MCA, MOCP, and FLA values.
3. The transmission (control) wiring distance between the indoor unit and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
4. The transmission (control) wiring between the indoor unit and the remote controller shall be a maximum distance of 1,640 feet.

I. Control:
1. The unit shall be controlled with a remote controller to perform input functions necessary to operate the system.
2. The unit shall be compatible with interfacing with a building management system (BMS) via optional BACnet gateways.

2.3 FOUR WAY BLOW CASETTE INDOOR FAN-EVAPORATOR UNITS

A. General:
1. The indoor unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. Both liquid and suction lines must be individually insulated between the outdoor and indoor units.

B. Unit Cabinet:
1. The indoor unit shall have a white, "wipe-clean" finish.
2. The drain and refrigerant piping shall be accessible from six (6) positions for flexible installation (right side, right back, and right bottom; and left side, left back, and left bottom.
3. The cabinet shall be supplied with a mounting plate to be installed onto a wall for securely mounting the cabinet.
4. The cabinet includes:
   a. Indoor unit ON/OFF switch, capable of being used when the remote controller is missing. When switch is used, the default setting is COOL mode, 76°F temperature setting, and AUTO airflow rate.
   b. OPERATION lamp that turns blue in COOL mode and yellow in FAN mode.
   c. TIMER lamp that blinks when activated
   d. A Signal Receiver that receives signals from the remote controller at a maximum distance of 23 ft. When the unit receives a signal, you will hear the following: 2 beeps – operation start, 1 beep – Setting changed, 1 long beep – Operation stop.

C. Fan:

1. The evaporator fan shall be an assembly consisting of a direct-driven fan by a single motor.
2. The fan shall be statically and dynamically balanced and operate on a motor with permanent lubricated bearings.
3. An auto-swing louver for adjustable air flow (vertically) is standard via the wireless remote control furnished with each system.
4. The indoor fan shall offer a choice of three speeds, plus quiet and auto settings.
5. The indoor fan shall be removable without the need to detach the heat evaporator coil or blower.

D. Filter:
1. The return air filter provided will be a removable and washable filter. Two titanium apatite air-purifying filters are included for additional air filtration.

E. Coil:
1. The evaporator coil shall be a nonferrous, aluminum fin on copper tube heat exchanger.
2. All tube joints shall be brazed with silver alloy or phoscopper.
3. All coils will be factory pressure tested.
4. A detachable condensate pan shall be provided under the coil with a drain connection.
5. The fins are to be covered with an anti-corrosion acrylic resin and hydrophilic film, rated for up to 500 hours salt spray.

F. Electrical:
1. The outdoor unit shall be powered with 208-230 volts, 1 phase, and 60 hertz power. The indoor unit shall receive 208-230 volt, 1 phase, 60 hertz power from the outdoor unit.
2. The allowable voltage range shall be 187 volts to 253 volts.

G. Control:
1. The unit shall have a backlit, wireless remote infra-red controller capable to operate the system. It shall have Cooling Operation, Dry Operation and Fan Only Operation.
2. The controller shall consist of an On/Off Power switch, Mode Selector, Fan Setting, Swing Louver, On/Off Timer Setting, Temperature Adjustment, °C or °F Temperature Display, Eco+ Mode, Quiet, Sleep, LED and Powerful Operation.
    a. On/Off switch powers the system on or off.
    b. Mode selector shall operate the system in cool, fan or dry operation.
    c. Fan setting shall provide three fan speeds, plus quiet and auto settings.
    d. Swing louver shall adjust the airflow (horizontal and vertical) blades.
        1) Vertical movement controlled via remote, horizontal movement controlled manually.
    e. On/Off timer is used for automatically switching the unit on or off at specific times during the day.
    f. Temperature adjustment allows for the increase or decrease of the desired temperature.
    g. Eco+ operation adjusts the operating condition to energy saving level by limiting the maximum power consumption of the air conditioner unit.
    h. Quiet operation reduces indoor unit sound pressure level by reducing the indoor unit fan speed.

i. Sleep operation automatically adjusts the temperature setting 0.9°F (0.5°C) up each hour for two hours in COOL to prevent excessive cooling during sleeping hours.
j. LED button shall change the indication display on the indoor unit.
k. Powerful operation allows quick cool down in the desired space to achieve maximum desired temperature in the shortest allowable time period.

3. The controller shall be able to display two-digit fault codes extracted from the indoor unit to aid in troubleshooting.
4. Temperature range on the remote control shall be 60°F to 86°F in cooling mode. The temperature shall be controlled in 1° increments.
5. The indoor unit microprocessor has the capability to receive and process commands via return air temperature and indoor coil temperature sensors enabled by commands from the remote control.
6. The unit shall also have the capability to connect to a smart-device app via wireless adapter

2.4 OUTDOOR HEAT PUMP CONDENSING UNITS

A. General: The outdoor unit is designed specifically for use with VRV series components.
1. The outdoor unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of a swing compressor, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separator, service ports and suction line accumulator.
2. Liquid and suction lines must be individually insulated between the outdoor and indoor units.
3. The outdoor unit can be wired and piped with outdoor unit access from the left, right, rear or bottom.
4. The connection ratio of indoor units to outdoor unit shall be permitted up to 130%.
5. The outdoor system shall be able to support the connection of up to 9 indoor units dependent on the model of the outdoor unit.
6. The sound pressure level standard shall be that value as listed in the engineering manual for the specified models at 3 feet from the front of the unit. The outdoor unit shall be capable of operating automatically at further reduced noise during night time.
7. The system will automatically restart operation after a power failure and will not cause any settings to be lost, thus eliminating the need for reprogramming.
8. The outdoor unit shall allow for side-by-side installation with minimum spacing.
9. The following safety devices shall be included on the condensing unit; high pressure switch, low pressure sensor, control circuit fuses, crankcase heaters, fusible plug, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.
10. To ensure the liquid refrigerant does not flash when supplying to the various indoor unit units, the circuit shall be provided with a sub-cooling feature.
11. Oil recovery cycle shall be automatic occurring 2 hours after start of operation and then every 8 hours of operation.
12. The outdoor unit shall be capable of heating operation at 0°F dry bulb ambient temperature without additional low ambient controls.

B. Unit Cabinet:

1. The outdoor unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.

C. Fan:
1. The condensing unit fan(s) shall consist of propeller type, direct-drive fan motors that have multiple speed operation via a DC (digitally commutating) inverter.
2. The fan motor shall have inherent protection and permanently lubricated bearings and be mounted.
3. The fan motor shall be provided with a fan guard to prevent contact with moving parts.

D. Condenser Coil:
1. The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design to ensure high efficiency performance.
3. The heat exchanger on the condensing units shall be manufactured from Hi-X seamless copper tube.
4. The fins are to be covered with an anti-corrosion acrylic resin and hydrophilic film type E1.

E. The inverter scroll compressor shall be variable speed (PAM inverter) controlled which is capable of changing the speed to follow the variations in total cooling and heating load as determined by the suction gas pressure as measured in the condensing unit. In addition, samplings of evaporator and condenser temperatures shall be made so that the high/low pressures detected are read every 20 seconds and calculated. With each reading, the compressor capacity shall be controlled to eliminate deviation from target value.
1. The inverter driven compressor in each condensing unit shall be of highly efficient reluctance DC (digitally commutating), hermetically sealed swing type.
2. Neodymium magnets shall be adopted in the rotor construction to yield a higher torque and efficiency in the compressor instead of the normal ferrite magnet type. At complete stop of the compressor, the neodymium magnets will position the rotor into the optimum position for a low torque start.
3. The capacity control range shall be 14% to 100%.
4. The compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.
5. Oil separators shall be standard with the equipment together with an intelligent oil management system.

F. Electrical:
1. The power supply to the outdoor unit shall be 208/230 volts, 1 phase, 60 hertz +/- 10%.
2. The control voltage between the indoor and outdoor unit shall be 18VDC non-shielded, stranded 2 conductor cable.
3. The control wiring shall be a two-wire multiplex transmission system, making it possible to connect multiple indoor units to one outdoor unit with one 2-cable wire, thus simplifying the wiring operation.

G. Operating Range
1. The operating range in cooling will be 23°F DB to 122°F DB (-5°C – 50°C).

2. The operating range in heating will be -4°F WB to 60°F WB (-20°C – 15.5°C).
3. Cooling mode indoor room temperature range will be 57°F-77°F WB (14°C – 25°C).
4. Heating mode indoor room temperature range will be 59°F-80°F DB (15°C – 26.6°C)

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's installation instructions.

B. Complete structural, mechanical, and electrical connections in accordance with manufacturer's installation instructions.

C. Provide for connection to electrical service. Refer to Division 26.

D. Install units on vibration isolation controls in accordance with Section 23 05 48.

E. Roof mounted: Install on raised support platform as indicated on the drawings.

F. Provide connection to refrigeration piping system and evaporators. Refer to Section 23 23 00. Comply with ASHRAE 15.

G. Furnish charge of refrigerant and oil.

H. Charge system with refrigerant and test entire system for leaks after completion of installation. Repair leaks, put system into operation, and test equipment performance.

I. Shut-down system if initial start-up and testing takes place in winter and machines are to remain inoperative. Repeat start-up and testing operation at beginning of first cooling season.

J. Provide cooling season start-up, and winter season shut-down for first year of operation.

K. Pipe condensate to nearest drain for indirect waste termination in accordance with the manufacturers requirements.

END OF SECTION

SECTION 23 82 00

CONVECTION HEATING AND COOLING UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Electric wall and ceiling heaters

B. Cabinet unit heaters (Hydronic)

1.2 RELATED SECTIONS

A. Section 23 05 00 – Common Work Results for HVAC

B. Section 23 05 13 – Common Motor Requirements for HVAC Equipment

C. Section 23 09 23 – Direct-Digital Control for HVAC

D. Section 23 21 13 – Hydronic Piping

E. Section 23 21 16 – Hydronic Piping Specialties

F. Section 23 40 00 – Air Cleaning Devices

1.3 REFERENCES

A. NFPA 70 - National Electrical Code

1.4 SUBMITTALS FOR REVIEW

A. Submit in accordance with Section 23 05 00.

B. Product Data: Provide date on fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels at rated capacity, dimensions, weights, connections, and electrical characteristics and connection requirements. List all options and accessories furnished with each fan.

C. Product Data: Provide rated capacities, weights, specialties and accessories, electrical requirements and wiring diagrams.

1.5 SUBMITTALS AT PROJECT CLOSEOUT

A. Submit under provisions of Section 23 05 00.

B. Project Record Documents: Record actual locations of panels, pipe connections, etc.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications:
1. Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.
2. Company shall be regularly engaged in the manufacture of radiant panels and have catalog performance data and certified test data.
3. Provide minimum on-site factory services specified in this section.
4. Unit shall be constructed in accordance with ETL and ETL, Canada standards. Units comply with the minimum requirements of the US and Canadian national product safety standard, UL 1995/CSA C22.2 No. 236. Factory-installed motors and electric heaters shall be UL approved. Insulation and adhesive shall meet NFPA-90A requirements for flame spread and smoke generation.
5. Coils shall be tested in accordance with AHRI standard 410, latest edition. Each coil shall be factory tested for leakage at 300-psig air pressure with coil submerged in water.

1.7 EXTRA MATERIALS (REFER TO SECTION 23 05 00)

A. Filters: Supply one set of spare filters in addition to the set at the time of substantial completion.

1.8 REGULATORY REQUIREMENTS

A. Products requiring electrical connections: listed and classified by UL as suitable for the purpose specified and indicated.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Unit shall be handled and stored in accordance with the manufacturer’s instructions.

PART 2 - PRODUCTS

2.1 CABINET UNIT HEATERS (HYDRONIC)

A. Manufacturers (refer to Section 23 05 00 – Common Work Results for HVAC – Equipment/Material Substitutions):
1. Trane
2. Sterling
3. Jaga
4. Modine

B. Heating Elements: Seamless copper tubing mechanically expanded into evenly spaced aluminum fins and cast iron headers, steel side plates and supports, factory air pressure tested at 100 psi under water, with means of adjusting pitch of element.
   1. Provide with air vent assembly to prevent accumulation of air in the heating element.

C. Fans: Centrifugal, forward curved and double width or tangential fan. Aluminum wheels in corrosion resistant sheet metal housing.

D. Motor: Tap wound multiple speed permanent split capacitor shaded pole with sleeve bearings or EC motor, resiliently mounted.

E. Includes chassis, fan casing, and motor. The fan board assembly shall include a quick disconnect plug. The structural frame chassis shall be 18 gauge steel and be continuous throughout the unit. Unit shall be acoustically and thermally insulated with closed cell foam insulation.

F. Mounting: Recessed ceiling mounted. Provide vibration isolation in accordance with Section 23 05 48.

G. Front Panel: Sloped vertical top. Minimum 16 gauge with access doors, bottom air inlet and top outlet and tamperproof screw fasteners. Air inlet and outlet shall be on same face of radiator. Refer to the schedules for basis of design mounting.

H. Filters: Provide with manufacturer's standard filters. Both the return and supply air shall be filtered. The filter shall be a permanent, cleanable style expanded aluminum filter.

I. Finish: Factory applied baked enamel in color selected by the Architect.

J. Capacity: As scheduled on the drawings.

2.2 ELECTRIC WALL AND CEILING HEATERS

A. Manufacturers: (refer to Section 23 05 00 – Common Work Results for HVAC – Equipment/Material Substitutions):
   1. Markel
   2. Berko
   3. Qmark
   4. Modine
   5. Reznor

B. General
   1. Heavy duty forced air electric heaters of the wattage, voltage and phase as indicated on the plans. The heater shall so be designed to provide an even distribution of heated air to the space to be heated by drawing return air in the peripheral area of the heater across and through the element which shall then be discharged from the center section of the heater by means of an electric motor and axial flow fan blade. Wall heaters shall be recessed mounted.

C. Enclosure:
   1. Heater front shall withstand 10.8 ft. lbs. impact and 400 lbs. static force applied to an 8 sq. in. area at center grille location with less than 1/16" permanent distortion. The

combination return and supply grille assembly shall be constructed of 1/16” x 3/8” rounded edge horizontal steel louvers which shall be spaced for maximum opening of ¼”. Louvers shall be welded at every intersection to three evenly spaced 1/16” diameter vertical members and completely framed in a heavy gauge natural anodized aluminum extrusion. Front assembly shall be attached to the chassis by hidden tamper-resistant (Allen-head) machine screws. All other parts shall be 16 gauge. Steel zinc coated, both sides finished in a high gloss colored baked enamel.

D. Motor:
1. Motor shall be permanently lubricated unit bearing, totally enclosed shaded pole type with impedance protection. Motors shall operate at no more than 1400 RPM and shall be same voltage as the heater. A protective shield shall surround the motor to separate return air from heated air.

E. Performance:
1. See schedules on drawings

F. Elements:
1. Element assemblies shall consist of two or three corrosion resistant steel sheathed type elements mechanically bonded to common corrosion resistant steel fins. Each sheeted element shall consist of helically coiled nickel chromium alloy resistant wire completely embedded in and surrounded by magnesium oxide, enclosed and wedged into corrosion resistant steel sheaths. Elements shall have 2” cold conductor pins extending into the sheath and shall have a density of no more than 60 watts per inch.

G. Thermal Overload:
1. Heaters shall be equipped with a “zero voltage reset” thermal overload which disconnects elements and motor in the event normal operating temperatures are exceeded. For safety, if opened due to abnormal temperature, thermal overload shall remain open until manually reset by turning heater off for five minutes. Automatic reset thermal overloads which allow the element to continue to cycle under abnormal conditions will not be accepted.

H. Approval:
1. Heaters shall be Underwriters’ Laboratories listed. Heaters shall conform to Underwriter’s Laboratories, Inc. standard 2021, and shall not be required to have any “CAUTION” marking on the front of the heater. Heaters not conforming to these paragraphs will not be acceptable.

I. Circuit Breakers:
1. Heaters shall be equipped with built-in circuit breakers in order to allow the heaters to be supplied from feeder taps. A separate switch providing positive off for control circuits shall be included where required. Circuit breakers and control switches shall be arranged so that all line side conductors will be separately enclosed when heater front is removed for servicing so that no current carrying parts are accessible without the use of additional tools.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions..

B. Install equipment exposed to finished areas after walls and ceiling are finished and painted. Avoid damage.

C. Protection: Provide finished cabinet units with protective covers during balance of construction.

D. Cabinet and Ceiling Heaters: Hang from building structure, with pipe hangers anchored to building, not from piping. Mount as high as possible to maintain greatest headroom unless otherwise indicated.

E. Provide required sheaves to achieve final air balance at no additional cost. This applies to fixed as well as adjustable sheaves.

F. Install with vibration isolation and seismic controls in accordance with Section 23 05 48 .

3.2 CLEANING

A. After construction is completed, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.

B. Touch-up marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.

C. Clean filters.

END OF SECTION

Electrical Specifications

SECTION 26 05 00

ELECTRICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 CONDITIONS AND REQUIREMENTS

A. Drawings and general provisions of the Contract, including agreement between the owner and CM/GC and Division 1 Specification Sections, apply to this Section.

B. Provisions of this Section shall apply to all Sections of Division 26, 27, and 28.

1.2 SCOPE OF WORK

A. Furnish and install all materials and equipment and provide all labor required and necessary to complete the work shown on the drawings and/or specified in all Sections of Division 26 and all other work and miscellaneous items, not specifically mentioned, but reasonably inferred for a complete installation, including all accessories required for testing the system. It is the intent of the drawings and specifications that all systems be complete and ready for operation.

1.3 CODE COMPLIANCE

A. All work and materials shall comply with the latest rules, codes and regulations, including, but not limited to, the following:

1. Occupational Safety and Health Act Standards (OSHA)
2. NFPA #70 – National Electric Code (NEC)
3. ADA Standards – Americans with Disabilities Act
4. ANSI/IEEE C-2 – National Electrical Safety Code
5. NECA – Standard of Installation

B. International Building Code

C. International Fire Code

D. International Energy Conservation Code

E. NFPA #72 – Fire Code

F. NFPA #101 – Life Safety Code

G. All other applicable Federal, State and local laws and regulations.

H. Work to be executed and inspected in accordance with local codes and ordinances. Permits, fees or charges for inspection or other services shall be paid for by the contractor. Local codes and ordinances are to be considered as minimum requirements and must be properly executed without expense to the owner; but do not relieve the contractor from work shown that exceeds minimum requirements.

1.4 CONDITIONS AT SITE

A. Visit to site is recommended for all bidders prior to submission of bid. All will be held to have familiarized themselves with all discernible conditions and no extra payment will be allowed for work required because of these conditions, whether specifically mentioned or not.

B. Lines of other services that are damaged because of this work shall be promptly repaired at no expense to the owner to the complete satisfaction of the owner.

1.5 DRAWINGS AND SPECIFICATIONS

A. All drawings and all specifications shall be considered as a whole, and work of this Division shown anywhere therein shall be furnished under this Division.

B. Drawings are diagrammatic and indicate the general arrangement of equipment and wiring. Most direct routing of conduits and wiring is not assured. Exact requirements shall be governed by architectural, structural, and mechanical conditions of the job. Consult all other drawings in preparation of the bid. Extra lengths of wiring or addition of pull or junction boxes, etc., necessitated by such conditions shall be included in the bid. Check all information and report any apparent discrepancies before submitting bid.

C. Changes to location, type, function, brand name, finish, etc., shall not be made without permission of engineer.

D. Some equipment is specifically designated on the drawings. It is not the intent to sole source any item unless explicitly stated. Items have been specified based upon design requirements. All bidders are encouraged to submit products for approval. Prior approval must be obtained as required by these contract documents. Bids submitted with non-approved items will be considered invalid and bidders will be held to provide approved materials at no additional cost to the owner. Submittals received by the engineer after award of contract on non-approved equipment will not be reviewed nor will they be returned.

E. Where conflicting directions are given within the specifications and drawings, the contractor shall include the most expensive option in the bid.

1.6 SAFETY AND INDEMNITY

A. Safety: The contractor shall be solely and completely responsible for conditions of the job site, including safety of all persons and property during performance of the work. This requirement will apply continuously and not be limited to normal working hours.

B. No act, service, drawing review or construction review by the owner is intended to include review of the adequacy of the contractor's safety measures in, on, or near the construction site.

1.7 CONSTRUCTION OBSERVATION BY THE ENGINEER

A. Prior to covering: any major portion of the materials installed under this section, notify the engineer so that an observation can be made. Notification shall be made at least three (3) working days in advance of the date the items will be covered.

1.8 INSTRUCTION OF OWNER'S PERSONNEL

A. The contractor shall conduct an on-site instructional tour of the entire project. The personnel designated by the owner shall be instructed in: operation of all electrical systems, trouble-shooting procedures, preventative maintenance procedures, uses of Operation and Maintenance manuals, maintenance and cleaning of lighting fixtures and operation of all special systems.

B. Contractor will include in his bid 8 hours of instruction time to be held at the project location after substantial completion for instruction of owner's personnel. Coordinate time and number of owner personnel to be present and provide schedule to engineer.

1.9 PROJECT COMPLETION

A. Upon completion of all work and operational checks on all systems, the contractor shall request that a final construction observation be performed.

B. The engineer shall compile a punch list of items to be completed or corrected. The contractor shall notify the engineer upon completion of the items.

1.10 GUARANTEE

A. All work under this section shall be guaranteed in writing to be free of defective work, materials, or parts for a period of one (1) year after final acceptance of the work under this contract or the period indicated under the Division 1 specifications whichever is longer.

B. Repair, revision or replacement of any and all defects, failure or inoperativeness shall be done by the contractor at no cost to the owner.

PART 2 - PRODUCTS

2.1 MATERIAL APPROVAL

A. The design, manufacturer and testing of electrical equipment and materials shall conform to or exceed latest applicable NEMA, IEEE or ANSI standards.

B. All materials must be new, unless noted otherwise, and UL listed. Materials that are not covered by UL testing standards shall be tested and approved by an independent testing laboratory or a governmental agency, which laboratory shall be acceptable to the owner and code enforcing agency.

2.2 SHOP DRAWINGS AND MATERIALS LIST

A. Submit an electronic copy, unless noted otherwise under Division 1, of Division 26, 27 and 28 shop drawings and material lists proposed for this project to the architect/engineer for review.

2.3 OPERATION AND MAINTENANCE MANUALS

A. Submit an electronic copy, unless noted otherwise under Division 1, of the Operation and Maintenance Manuals for all Division 26, 27 and 28 equipment to the architect/engineer.

2.4 RECORD DRAWINGS

A. Submit record drawings to owner.

2.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver, store, and handle materials in a manner to prevent damage.

B. Protect equipment from weather and dampness.

PART 3 - EXECUTION

3.1 WORKMANSHIP AND CONTRACTOR'S QUALIFICATIONS

A. Only quality workmanship will be accepted. Haphazard or poor installation

practice will be cause for rejection of work.

B. Provide experienced foreman with a minimum of three years experience working on this type of building placed in charge of this work at all times.

3.2 COORDINATION

A. Coordinate work with other trades to avoid conflict and to provide correct rough-in and connection for equipment furnished under trades that require electrical connections. Inform contractors of other trades of the required access to and clearances around electrical equipment to maintain serviceability and code compliance.

B. Verify equipment dimensions and requirements with provisions specified under this Section. Check actual job conditions before fabricating work. Report necessary changes in time to prevent needless work. Changes or additions subject to additional compensation, which are made without the authorization of the owner, shall be at contractor's risk and expense.

3.3 MANUFACTURER'S INSTRUCTIONS

A. All installations are to be made in accordance with manufacturer's recommendations. A copy of such recommendations shall at all times be kept in the job superintendent's office and shall be available to the engineer.

B. Follow manufacturer's instructions where they cover points not specifically indicated on drawings and specifications. If they conflict with the drawings and specifications, obtain clarification from the engineer before starting work.

3.4 QUALITY ASSURANCE

A. The contractor shall insure that all workmanship, all materials employed, all required equipment and the manner and method of installation conforms to accepted construction and engineering practices, and that each piece of equipment is in satisfactory working condition to satisfactorily perform its functional operation.

B. Provide quality assurance tests and operational check on all components of the electrical distribution system, all lighting fixtures, and special systems.

3.5 CUTTING AND PATCHING

A. Perform all cutting and fittings required for work of this section in rough construction of the building.

B. All patching of finished construction of building shall be performed under the

sections of specifications covering these materials.

C. No joists, beams, girders, or columns shall be cut by any contractor without obtaining written permission from the architect/engineer.

END OF SECTION

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SECTION 26 05 02

SHORT-CIRCUIT/COORDINATION STUDY/ARC FLASH HAZARD ANALYSIS

PART 1 - GENERAL

1.1 SCOPE

A. The contractor shall furnish short-circuit and protective device coordination studies as prepared by the electrical equipment manufacturer or a professional licensed engineer. The final report shall be stamped/singed by a professional engineer licensed in the state the project is located.

B. The contractor shall furnish an Arc Flash Hazard Analysis Study per the requirements set forth in NFPA 70E-Standard for Electrical Safety in the Workplace. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in the current version of NFPA70E.

C. The scope of the studies shall include all distribution equipment supplied under this contract.

1.2 RELATED DOCUMENTS

A. 26 05 01 – Field Test and Operational Check

B. 26 24 13 - Main Switchboards

C. 26 24 16 – Panelboards

1.3 REFERENCES

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
   2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
   3. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis
   4. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings
   5. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.
   6. IEEE 1584 - Guide for Performing Arc-Flash Hazard Calculations.

B. American National Standards Institute (ANSI):

1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
2. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures
3. ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis
4. ANSI C 37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories.

C. The National Fire Protection Association (NFPA):
1. NFPA 70 - National Electrical Code, latest edition
2. NFPA 70E – Standard for Electrical Safety in the Workplace

1.4 SUBMITTALS FOR REVIEW/APPROVAL

A. The short-circuit and protective device coordination studies shall be submitted to the design engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the engineer may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory.

1.5 SUBMITTALS FOR CONSTRUCTION

A. The results of the short-circuit, protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. Five (5) bound copies of the complete final report shall be submitted. For large system studies. Additional copies of the short-circuit input and output data, where required, shall be provided on CD in PDF format.

B. The report shall include the following sections:
1. Executive Summary
2. Descriptions, purpose, basis and scope of the study
3. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties
4. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip unit settings, fuse selection
5. Fault current calculations including a definition of terms and guide for interpretation of the computer printout
6. Details of the incident energy and flash protection boundary calculations
7. Recommendations for system improvements, where needed
8. One-line diagram
9. Arc flash labels shall be provided in hard copy.

1.6 QUALIFICATIONS

A. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the supervision and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies.

1.7 COMPUTER ANALYSIS SOFTWARE

A. The studies shall be performed using the latest revision of:
   1. SKM Systems Analysis Power*Tools for Windows (PTW) software program
   2. Easy Power
   3. Or Pre-Approved Software.

PART 2 - PRODUCT

2.1 STUDIES

A. Contractor to furnish short-circuit and protective device coordination studies as prepared by equipment manufacturer or an approved engineering firm.

B. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E - Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D.

2.2 DATA COLLECTION

A. Contractor shall furnish all data as required by the power system studies. The Engineer performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.

B. Source combination may include present and future motors and generators.

C. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner, or Contractor.

D. If applicable, include fault contribution of existing motors in the study. The Contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.

2.3 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

A. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standard 141-1993.

B. Transformer design impedances shall be used when test impedances are not available.

C. Provide the following:
1. Calculation methods and assumptions
2. Selected base per unit quantities
3. One-line diagram of the system being evaluated
4. Source impedance data, including electric utility system and motor fault contribution characteristics
5. Tabulations of calculated quantities
6. Results, conclusions, and recommendations.

D. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:
1. Electric utility's supply termination point
2. Incoming switchgear
3. Low voltage switchgear
4. Motor control centers
5. Branch circuit panelboards
6. Other significant locations throughout the system.

E. For grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short-circuit study.

F. Protective Device Evaluation:
1. Evaluate equipment and protective devices and compare to short circuit ratings
2. Adequacy of switchgear, motor control centers, and panelboard bus bars to withstand short-circuit stresses
3. Notify Owner in writing, of existing, circuit protective devices improperly rated for the calculated available fault current.

2.4 PROTECTIVE DEVICE COORDINATION STUDY

A. Proposed protective device coordination time-current curves (TCC) shall be displayed on log-log scale graphs.

B. Include on each TCC graph, a complete title and one-line diagram with legend identifying the specific portion of the system covered.

C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.

D. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

E. Plot the following characteristics on the TCC graphs, where applicable:
1. Electric utility's overcurrent protective device
2. Medium voltage equipment overcurrent relays
3. Medium and low voltage fuses including manufacturer's minimum melt, total

clearing, tolerance, and damage bands
4. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands
5. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves
6. Conductor damage curves
7. Ground fault protective devices, as applicable
8. Pertinent motor starting characteristics and motor damage points, where applicable
9. Pertinent generator short-circuit decrement curve and generator damage point
10. The largest feeder circuit breaker in each motor control center and applicable panelboard.

F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

2.5 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D.

B. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.

C. The Arc-Flash Hazard Analysis shall include all significant locations in 240 volt and 208 volt systems fed from transformers equal to or greater than 75KkVA where work could be performed on energized parts.

D. Safe working distances shall be based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm2.

E. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.

F. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.

G. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:
   1. Fault contribution from induction motors should not be considered beyond 3-5 cycles.
   2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g. contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).

H. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.

I. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.

J. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.

K. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

2.6 REPORT SECTIONS

A. Input data shall include, but not be limited to the following:
   1. Feeder input data including feeder type (cable or bus), size, length, number per phase, conduit type (magnetic or non-magnetic) and conductor material (copper or aluminum).
   2. Transformer input data, including winding connections, secondary neutral-ground connection, primary and secondary voltage ratings, kVA rating, impedance, % taps and phase shift.
   3. Reactor data, including voltage rating, and impedance.
   4. Generation contribution data, (synchronous generators and Utility), including short-circuit reactance (X”d), rated MVA, rated voltage, three-phase and single line-ground contribution (for Utility sources) and X/R ratio.
   5. Motor contribution data (induction motors and synchronous motors), including short-circuit reactance, rated horsepower or kVA, rated voltage, and X/R ratio.

B. Short-Circuit Output Data shall include, but not be limited to the following reports:

1. Low Voltage Fault Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
   a. Voltage
   b. Calculated fault current magnitude and angle
   c. Fault point X/R ratio
   d. Equivalent impedance
2. Momentary Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
   a. Voltage
   b. Calculated symmetrical fault current magnitude and angle
   c. Fault point X/R ratio
   d. Calculated asymmetrical fault currents
      1) Based on fault point X/R ratio
      2) Based on calculated symmetrical value multiplied by 1.6
      3) Based on calculated symmetrical value multiplied by 2.7
   e. Equivalent impedance
3. Interrupting Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
   a. Voltage
   b. Calculated symmetrical fault current magnitude and angle
   c. Fault point X/R ratio
   d. No AC Decrement (NACD) Ratio
   e. Equivalent impedance
   f. Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a symmetrical basis
   g. Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a total basis

C. Recommended Protective Device Settings:
   1. Phase and Ground Relays:
      a. Current transformer ratio
      b. Current setting
      c. Time setting
      d. Instantaneous setting
      e. Recommendations on improved relaying systems, if applicable.
   2. Circuit Breakers:
      a. Adjustable pickups and time delays (long time, short time, ground)
      b. Adjustable time-current characteristic
      c. Adjustable instantaneous pickup
      d. Recommendations on improved trip systems, if applicable.

D. Incident energy and flash protection boundary calculations
   1. Arcing fault magnitude
   2. Protective device clearing time
   3. Duration of arc
   4. Arc flash boundary

5. Working distance
6. Incident energy
7. Hazard Risk Category
8. Recommendations for arc flash energy reduction

PART 3 - EXECUTION

3.1 FIELD ADJUSTMENT

A. Adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the engineering service division of the equipment manufacture or the approved testing agencies listed in the related testing section(s).

B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

C. Notify Owner in writing of any required major equipment modifications.

3.2 ARC FLASH WARNING LABELS

A. The contractor of the Arc Flash Hazard Analysis shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.

B. All labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to the owner and after any system changes, upgrades or modifications have been incorporated in the system.

C. The label shall include the following information, at a minimum:
1. Location designation
2. Nominal voltage
3. Flash protection boundary
4. Hazard risk category
5. Incident energy
6. Working distance
7. Engineering report number, revision number and issue date.

D. Labels shall be machine printed, with no field markings.

E. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.
1. For each 600, 480 and applicable 208 volt panelboard, one arc flash label shall be provided.
2. For each motor control center, one arc flash label shall be provided.
3. For each low voltage switchboard, one arc flash label shall be provided.
4. For each switchgear, one flash label shall be provided.
5. For medium voltage switches one arc flash label shall be provided.

F. Labels shall be installed by the engineering service division of the equipment manufacture or the approved testing agencies listed in the related testing section(s).

3.3 ARC FLASH TRAINING

A. The contractor of the Arc Flash Analysis shall train the owner's qualified electrical personnel of the potential arc flash hazards associated with working on energized equipment (minimum of 4 hours).

END OF SECTION

SECTION 26 05 19

CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including agreement between the owner and CM/GC and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

1.3 SUBMITTALS

A. Submit shop drawings and product data.

1.4 COORDINATION

A. Coordinate layout and installation of cables with other installations.

B. Revise locations and elevations from those indicated, as required to suit field conditions and as approved by the owner.

PART 2 - PRODUCTS

2.1 BUILDING WIRES AND CABLES

A. Conductors: Stranded, copper, 600 volt insulation, type THHN/THWN, THHN/THWN-2, XHHN/XHHW.

B. Conductors:

C. Solid or stranded for No. 10 and smaller, stranded for No. 8 and larger, copper, 600 volt insulation, type THHN/THWN. Aluminum conductors not allowed unless noted otherwise.

1. Insulation Types: THWN-2 for underground, THWN for wet locations, THHN for dry locations; XHHN/XHHW for GFI branch circuits and feeders fed from GFCI breakers.

D. Color-code 208/120-V system secondary service, feeder, and branch-circuit conductors throughout the secondary electrical system as follows:
1. Phase A: Black.
2. Phase B: Red.
3. Phase C: Blue.
4. Neutral: White.
5. Ground: Green.
6. Isolated ground: Green with yellow tracer.

E. Color-code 480/277-V system secondary service, feeder, and branch-circuit conductors throughout the secondary electrical system as follows:
1. Phase A: Brown.
2. Phase B: Orange.
3. Phase C: Yellow.
4. Neutral: White or gray.
5. Ground: Green.

F. Wire connectors and splices: units of size, ampacity rating, material, type and class suitable for service indicated.

G. Signal and communication circuits:
1. Special cables as indicated on the drawings.
2. Conductors for general use: stranded copper conductor, #16 AWG minimum, with THWN-2 insulation for underground, THWN for wet locations and THHN insulation for dry locations.

PART 3 - EXECUTION

3.1 GENERAL WIRING METHODS

A. Examine raceways and building finishes to receive wires and cables for compliance with requirements for installation tolerances and other conditions affecting performance of wires and cables. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Use no wire smaller than #12 AWG for power and lighting circuits and no smaller than #18 AWG for control wiring.

C. The contractor is responsible for upsizing conductor sizes to ensure the maximum voltage drop of any branch circuit does not exceed 3%. For reference, use No. 10 AWG conductor for 20 Amp, 120 volt branch circuits longer than 75 feet, and for 20 Amp, 277 volt branch circuits longer than 200 feet.

D. Place an equal number of conductors for each phase of a circuit in the same raceway or conduit.

E. Splice only in junction or outlet boxes.

F. Neatly train or lace wiring inside boxes, equipment, and panelboards.

G. Make conductor lengths for parallel circuits equal.

H. Provide a separate neutral conductor for each ungrounded conductor. Ungrounded conductors may share a neutral when all of the following conditions are met:

I. The ungrounded conductors are connected to a multi-pole breaker or breakers that are clipped together with a UL listed means that provide a common trip.

J. The ungrounded conductors contained in the same conduit or raceway.

K. The ungrounded conductors all originate from a separate and unique phase bus in the panel.

3.2 INSTALLATION

A. Install wires and cables as indicated, according to manufacturer's written instructions, and the “National Electrical Installation Standards" by NECA.

B. Remove existing wires from raceway before pulling in new wires and cables.

C. Pull Conductors: Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means; including fish tape, cable, rope, and basket weave wire/cable grips that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables above accessible ceilings; do not rest on ceiling tiles. Do not fasten cables to ceiling support wires. Use cable ties to support cables from structure.

3.3 CONNECTIONS

A. Conductor Splices: Keep to minimum.

B. Install splices and tapes that possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.

C. Use splice and tap connectors compatible with conductor material.

D. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches of slack.

E. Connect outlets and components to wiring and to ground as indicated and instructed by manufacturer.

F. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.

G. Terminate spare conductors with electrical tape.

3.4 LABELING

A. Provide Brady wire markers or equivalent on all conductors. All wire shall be labeled in each box and panel with the circuit number and panel identification.

3.5 FIELD QUALITY CONTROL

A. Inspect wire and cable for physical damage.

B. Perform continuity testing on all power and equipment branch circuit conductors. Verify proper phasing connections.

END OF SECTION

SECTION 26 05 26

GROUNDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including agreement between the owner and CM/GC and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

1.3 SYSTEM DESCRIPTION

A. Ground the electrical service system neutral at service entrance equipment to concrete encased electrode, metal underground water pipe, and effectively grounded metal frame of building.

B. Ground each separately-derived system neutral to nearest effectively grounded metal structural frame of building or point of service entrance ground.

C. Provide communications system grounding conductor to point of service entrance ground.

D. Bond together system neutrals, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, grounding conductors in raceways and cables, receptacle ground connectors, and plumbing systems.

1.4 QUALITY ASSURANCE

A. Testing: Refer to Section 26 05 01 – Field Test and Operational Check.

PART 2 - PRODUCTS

2.1 GROUNDING CONDUCTORS

A. For insulated conductors, comply with Section 260519 - Conductors and Cables.

B. Material: Copper.

C. Equipment Grounding Conductors: Insulated with green-colored insulation. Where green insulation is not available, on larger sizes, black insulation shall be used and suitably identified with green tape at each junction box or device enclosure.

D. Isolated Ground Conductors: Insulated with green-colored insulation with yellow tracer. Where not available, green and yellow tape at each junction box or device enclosure.

E. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.

F. Bare Copper Conductors: Medium hard drawn copper conductor, stranded, sized as shown on the drawings.

G. Hardware: Bolts, nuts and washers shall be bronze; cadmium plated steel or other non-corrosive material, approved for the purpose.

H. Grounding Bus: Bare, annealed copper bars of rectangular cross section, with insulators.

2.2 CONNECTOR PRODUCTS

A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.

B. Bolted Connectors: Bolted-pressure-type connectors, or compression type.

C. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

D. Below grade compression fittings: Thomas & Betts, Series 52000, 53000, and 54000 or equivalent.

E. Use connector and sealant approved for purpose on all below grade clamp or compression type connections.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel, 5/8 inch diameter, minimum length 8 feet.

PART 3 - EXECUTION

3.1 APPLICATION

A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.

B. In raceways, use insulated equipment grounding conductors.

C. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections.

D. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.

E. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Use insulated spacer; space 1 inch from wall and support from wall 6 inches above finished floor, unless otherwise indicated.

F. Underground Grounding Conductors: Use copper conductor, No. 2/0 AWG minimum. Bury at least 24 inches below grade.

3.2 EQUIPMENT GROUNDING CONDUCTORS

A. Comply with NEC Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NEC are indicated.

B. Install equipment grounding conductors in all feeders and circuits.

C. Install insulated equipment grounding conductor with circuit conductors for the following items, in addition to those required by NEC:
1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.

D. Computer Outlet Circuits: Install insulated equipment grounding conductor in branch-circuit runs from computer-area power panels or power-distribution units.

E. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate grounding conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

F. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways bonded to outlet or equipment, sized per Section 250 of the NEC.

G. Signal and Communication Systems: For telephone, alarm, voice and data, and other

communication systems, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on grounding bar.
2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

H. Provide green insulated ground conductor to exterior post light standards.

I. Provide grounding and bonding at pad-mounted transformer in accordance with Section 261200.

3.3 INSTALLATION

A. Ground Rods: Where indicated, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes.

1. Drive ground rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.
2. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, unless otherwise indicated. Make connections without exposing steel or damaging copper coating.

B. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

C. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

D. Metal Water Service Pipe: Provide insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

E. UFER Ground (Concrete-Encased Grounding Electrode): Fabricate according to NEC 250, using a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to a grounding electrode external to concrete.

3.4 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
   1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
   2. Make connections with clean, bare metal at points of contact.
   3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
   4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
   5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

D. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically non-continuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

E. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values.

F. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

G. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.5 SYSTEM NEUTRAL GROUND

A. Ground the neutral conductor of each transformer or generator to limit the maximum potential above ground due to normal operating voltage and limit the voltage level due to abnormal conditions.

B. Ground generators or transformers with secondary voltage 600 volt or less as follows:

C. 3 phase, 4 wire Wye connected: ground neutral point

D. For transformers 75 kVA or smaller with primary voltage 480 volt or less the primary equipment ground conductor may be used for grounding the secondary neutral provided it is adequately sized in accordance with NEC system ground conductor size.

3.6 EQUIPMENT GROUND

A. Ground non-current carrying metal parts of electrical equipment enclosures, frames, conductor raceways or cable trays to provide a low impedance path for line-to-ground fault current and to bond all non-current carrying metal parts together. Install a grounding conductor in each raceway system. Equipment grounding conductor shall be electrically and mechanically continuous from the electrical circuit source to the equipment to be grounded. Size grounding conductors per NEC 250 unless otherwise shown on the drawings.

B. Install metal raceway couplings, fittings, and terminations secure and tight to ensure good grounding continuity. Provide grounding conductor sized per NEC through all raceway and conduit systems.

C. Lighting fixtures shall be securely connected to equipment grounding conductors. Outdoor lighting standards shall have a factory installed ground lug for terminating the grounding conductor.

D. Motors shall be connected to equipment ground conductors with a bolted solderless lug connection on the metal frame.

3.7 FIELD QUALITY CONTROL

A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

B. Test ground system per Section 26 05 01.

END OF SECTION

SECTION 26 05 33

RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including agreement between the owner and CM/GC and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. FMC: Flexible metal conduit.

C. IMC: Intermediate metal conduit.

D. LFMC: Liquidtight flexible metal conduit.

E. RMC: Rigid metal conduit.

F. RNC: Rigid Polyvinyl Chloride conduit.

G. PVC: Rigid Polyvinyl Chloride conduit

H. HDPE: High Density Polyethylene Conduit

1.4 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

1.5 COORDINATION

A. Coordinate layout and installation of raceways and boxes with other construction elements to ensure adequate headroom, working clearance, and access.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

A. Rigid Steel Conduit: ANSI C80.1.

B. IMC: ANSI C80.6.

C. PVC coated Steel Conduit and Fittings: NEMA RN 1; rigid steel conduit with external 40 mil PVC coating and internal two mil urethane coating.

D. EMT and Fittings: ANSI C80.3. Fittings: Set-screw type.

E. FMC: Zinc-coated steel.

F. LFMC: Flexible steel conduit with PVC jacket. Fittings: NEMA FB 1; compatible with conduit/tubing materials.

2.2 NONMETALLIC CONDUIT AND TUBING

A. RNC: NEMA TC 2, Schedule 40 PVC. Fittings: NEMA TC 3; match to conduit and material.

2.3 METAL WIREWAYS

A. Material: Sheet metal sized and shaped as indicated.

B. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

C. Finish: Manufacturer's standard enamel finish.

2.4 OUTLET AND DEVICE BOXES

A. Sheet Metal Boxes: NEMA OS 1, galvanized steel.

B. Cast-Metal Boxes: NEMA FB 1, Type FD, cast box with gasketed cover.

2.5 FLOOR BOXES

A. Floor Boxes: Cast metal, fully adjustable, rectangular, unless otherwise specified.

2.6 PULL AND JUNCTION BOXES

A. Small Sheet Metal Boxes: NEMA OS 1, galvanized steel.

B. Cast-Metal Boxes: NEMA FB 1, cast aluminum with gasketed cover.

2.7 ENCLOSURES AND CABINETS

A. Hinged-Cover Enclosures: NEMA 250, Type 1, 3R, or 4, with continuous hinge cover and flush latch, key operable.

B. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

C. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage, and include accessory feet where required for freestanding equipment.

2.8 J-HOOKS

A. J-hooks: Steel, rated for indoor use in non-corrosive environments. J-hooks shall be rated to support Category 5e cable.

B. Fittings and Support Bodies: Manufacturer’s recommended fittings including side mount flange clips, bottom mount flange clips, beam clamp, rod and flange clip, C & Z purlin clip, and all other components and assemblies to make the system work.

C. Acceptable Product: Caddy CableCat Hanging System, 1-5/16” and 2” hooks, or approved equal

D. Acceptable Manufacturer: Erico Fastening Products or approved equal.

E. J-hook Supports: Manufacturer’s recommended fastening devices.

2.9 INNERDUCT

A. Innerduct: NEMA TC 5. UL Listed, corrugated, specifically designed for optical fiber cable pathways.

B. Acceptable Manufactures: Arnco, Carlon, Dura-line, and Pyramid.

C. Composition:
1. Non-plenum rated: Polyethylene (PE), or High Density Polyethylene (HDPE).
2. Plenum rated: per manufacturer.

D. Nominal Size: 1” (inside diameter), minimum.

E. Pulling Strength: minimum of 600 pounds.

F. Color: Orange, solid.

G. Fittings and Innerduct Bodies: Manufacturer's recommended fittings including couplings, adapters, end caps, end bells, expansion couplings, plugs, sleeves, a full compliment of connective devices, and all other components to make the system work.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces to receive raceways, boxes, enclosures, and cabinets for compliance with installation tolerances and other conditions affecting performance of raceway installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 WIRING METHODS

A. Outdoors: Use the following wiring methods:
1. Exposed: Rigid steel or IMC.
2. Concealed: Rigid steel or IMC.
3. Underground, Single Run: RNC or PVC Externally Coated Rigid Steel Conduit where required by NEC 517.13.
4. Underground, Grouped: RNC or PVC Externally Coated Rigid Steel Conduit where required by NEC 517.13.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
6. Boxes and Enclosures: NEMA 250, Type 3R or Type 4.

B. Indoors: Use the following wiring methods:
1. Exposed: EMT or "Wiremold" metallic raceways or equal.
2. Exposed in public areas: "Wiremold" metallic raceways or equal. Use of exposed raceways in public areas must be approved by the architect prior to installation for each location. Use of exposed EMT in areas visible to the public is not allowed unless specifically approved by the architect prior to installation. Replacement of unapproved installations of exposed raceways will be at the expense of the contractor if deemed necessary by the architect or engineer.
3. Concealed: EMT or MC-Cable. Note: MC-Cable is not approved for "homeruns"
4. Concealed in Patient Care Areas: EMT or Hospital Grade MC-Cable where allowed by code. Note: Hospital Grade MC-Cable is not approved for "homeruns"
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC; except in wet or damp locations, use LFMC.
6. Damp or Wet Locations: Rigid steel conduit.
7. Boxes and Enclosures: NEMA 250, Type 1, except as follows:
    a. Damp or Wet Locations: NEMA 250, Type 4, stainless steel.

3.3 INSTALLATION

A. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer's written instructions.

B. Minimum Raceway Size: 1/2-inch trade size. 3/4-inch minimum for “homeruns”.

C. Conceal conduit and EMT, unless otherwise indicated, within finished walls, ceilings, and floors.

D. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

E. Install raceways level and square and at proper elevations. Provide adequate headroom.

F. Complete raceway installation before starting conductor installation.

G. Route exposed conduit and conduit above accessible ceilings parallel and perpendicular to walls and adjacent piping.

H. Use temporary closures to prevent foreign matter from entering raceways.

I. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portion of bends is not visible above the finished slab.

J. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated.

K. Use raceway fittings compatible with raceways and suitable for use and location. For intermediate steel conduit, use threaded rigid steel conduit fittings, unless otherwise indicated.

L. Run concealed raceways, with a minimum of bends, in the shortest practical distance considering the type of building construction and obstructions, unless otherwise indicated.

M. Raceways Embedded in Slabs: Install in middle third of slab thickness where practical, and leave at least 1-inch concrete cover.
   1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
   2. Space raceways laterally to prevent voids in concrete.
   3. Run conduit larger than 1-inch trade size parallel to or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
   4. Transition from nonmetallic tubing to rigid steel conduit or IMC before rising above floor.

N. Install exposed raceways parallel to or at right angles to nearby surfaces or structural members, and follow the surface contours as much as practical.

1. Run parallel or banked raceways together, on common supports where practical.
2. Make bends in parallel or banked runs from same centerline to make bends parallel. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.

O. Join raceways with fittings designed and approved for the purpose and make joints tight.
1. Make raceway terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.
2. Use insulating bushings to protect conductors.

P. Tighten set screws of threadless fittings with suitable tools.

Q. Terminations: Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against the box. Where terminations are not secure with 1 locknut, use 2 locknuts: 1 inside and 1 outside the box.

R. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align raceways so the coupling is square to the box and tighten the chase nipple so no threads are exposed.

S. Install pull wires in empty raceways. Utilize polyester line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of the pull wire.

T. Telephone and Signal System Raceways: In addition to the above requirements, install raceways in maximum lengths of 150 feet and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.

U. Install raceway sealing fittings according to manufacturer's written instructions. Locate fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
1. Where conduits pass from warm to cold locations, such as the boundaries of refrigerated spaces.
2. Where conduit pass from the interior to the exterior of a building.
3. Where otherwise required by NEC.

V. Apply firestopping to cable and raceway penetrations of fire-rated floor, ceiling, and wall assemblies to achieve fire-resistance rating of the assembly. Boxes installed in fire-rated floor, ceiling, and wall assemblies shall result in no larger than a 16 square-inch penetration in the fire-rated wall surface and the quantity of penetrations shall not be greater than 100 square-inches for every 100 square feet of fire-rated wall area. Where boxes are located on both sides of a fire-rated wall, the boxes shall have a minimum of a 24” horizontal spacing, where a 24” horizontal spacing cannot be achieved, furnish and install listed fire-rated putty on the boxes as required by the IBC.

W. Route conduit through roof openings for piping and ductwork where possible; otherwise, install roof penetrations in accordance with roofing system requirements. Coordinate with roofing installer.

X. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with the finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches above the floor. Install screwdriver-operated, threaded flush plugs flush with floor for future equipment connections.

Y. Flexible Connections: Use maximum of 6 feet of flexible conduit for recessed and semi-recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use liquidtight flexible conduit in wet or damp locations. Install separate ground conductor across flexible connections.

Z. PVC Externally Coated, Rigid Steel Conduits: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits.

AA. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying the raceways to receptacle or fixture ground terminals.

BB. Conduits shall not be routed on or above the roof without prior approval from the Engineer. Instead, the branch circuits shall be routed at the structure level below the roof to feed roof-top equipment. When approval is granted to route conduits on or above the roof, the conduits shall be strapped to COOPER industries DB series support blocks at intervals not exceeding NEC requirements. The conduits shall not be rested directly on the roof. It shall be permissible to penetrate the roof adjacent mechanical or electrical equipment to power that respective equipment.

3.4 SUPPORT INSTALLATION

A. Install support devices to securely and permanently fasten and support electrical components.

B. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.

C. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers, at least every 8 feet.

D. Size supports for multiple raceway installations so capacity can be increased by a 25 percent minimum in the future.

E. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.

F. Install 1/4-inch diameter or larger threaded steel hanger rods, unless otherwise indicated.

G. Spring-steel fasteners specifically designed for supporting single conduits or tubing may be used instead of malleable-iron hangers for 1-1/2-inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to slotted channel and angle supports.

H. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.

I. Simultaneously install vertical conductor supports with conductors.

J. Separately support cast boxes that are threaded to raceways and used for fixture support. Support sheet-metal boxes directly from the building structure or by bar hangers. If bar hangers are used, attach bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than 24 inches from the box.

K. Install metal channel racks for mounting cabinets, panelboards; disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.

L. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.

M. Securely fasten electrical items and their supports to the building structure, unless otherwise indicated. Do not fasten supports to piping, ductwork, mechanical equipment, or conduit. Perform fastening according to the following unless other fastening methods are indicated:
   1. Masonry: Toggle bolts on hollow masonry units and expansion bolts on solid masonry units.
   2. New Concrete: Concrete inserts with machine screws and bolts.
   3. Existing Concrete: Expansion bolts.
   4. Steel: Spring-tension clamps on steel.
   5. Light Steel: Sheet-metal screws.
   6. Fasteners: Select so the load applied to each fastener does not exceed 25 percent of its proof-test load.

N. Do not drill structural steel members.

O. All supports and attachments shall meet project seismic zone requirements.

3.5 BOX INSTALLATION

A. Do not install boxes back-to-back in walls.

B. Locate boxes in masonry walls to require cutting of masonry unit edge only. Coordinate masonry cutting to achieve neat openings for boxes.

C. Provide knockout closures for unused openings.

D. Support boxes independently of conduit except for cast boxes that are connected to two rigid metal conduits, both supported within 12 inches of box.

E. Use 4” boxes with multiple-gang mudring where more than one device are mounted together; do not use sectional boxes. Provide barriers to separate wiring of different voltage systems.

F. Install boxes in walls without damaging wall insulation.

G. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.

H. Position outlets to locate lighting fixtures as shown on reflected ceiling plans.

I. In inaccessible ceiling areas, position outlets and junction boxes within 6 inches of recessed luminaire, to be accessible through luminaire ceiling opening.

J. Provide recessed outlet boxes in finished areas; secure boxes to interior wall and partition studs, accurately positioning to allow for surface finish thickness. Use stamped steel stud bridges for flush outlets in hollow stud walls, and adjustable steel channel fasteners for flush ceiling outlet boxes.

K. Align wall-mounted outlet boxes for switches, thermostats, and similar devices.

L. For boxes installed in metal construction, use rigid support metal bar hangers or metal bar fastened to two studs or with metal screws to metal studs.

M. Set floor boxes level and adjust to finished floor surface.

N. Set floor boxes level and trim after installation to fit flush to finished floor surface.

O. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

P. Locate pull and junction boxes above accessible ceilings or in unfinished areas. Support pull and junction boxes independent of conduit.

Q. Minimum box size to be 4” square by 2 1/8” deep.

3.6 LABELING

A. Label coverplate of all pull and junction boxes by system served. Indicate panel circuits for power and lighting boxes.

3.7 CLEANING

A. On completion of installation, including outlet fittings and devices, inspect exposed

finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

END OF SECTION

SECTION 26 05 43

UNDER SLAB AND UNDERGROUND ELECTRICAL WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including agreement between the owner and CM/GC and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes under slab conduits and related electrical work.

PART 2 - PRODUCTS

2.1 CONDUIT

A. All shall be provided with fittings and accessories approved for the purpose. Refer to Section 260533.

2.2 PRECAST CONCRETE MANHOLE

A. Structural reinforced, size as indicated, with inserts for cable racks and pully eyes.

2.3 BARE COPPER GROUND CONDUCTOR

A. Medium hard drawn copper conductor, # 4/0 AWG stranded (unless otherwise noted).

PART 3 - EXECUTION

3.1 GENERAL

A. Electrical system layouts indicated on the drawings are generally diagrammatic but shall be followed as closely as actual construction and work of other trades will permit.

3.2 CONDUIT INSTALLATION

A. Plastic conduit shall be installed on 2 inch sand base and covered by 2 inch sand back

fill. Multiple runs shall maintain 3 inch minimum separation between runs. Plastic conduit shall not be installed in rock base.

B. Underground conduit entering building shall be provided with one 10 foot section of rigid steel conduit at point of penetration of foundation, footing or basement wall, with approximately equal lengths inside and outside building line. Ream the smaller inside diameter conduit smooth to prevent conductor damage.

C. Stagger conduit couplings by a minimum of 12 inches. All risers to grade shall be rigid steel.

D. All rigid steel conduits shall be encased in 3 inch minimum concrete envelope.

E. After completion of concrete encased duct bank, a 12 inch mandrel, ¼ inch less in diameter than a conduit, shall be pulled through each conduit.

F. Install 1/8 inch diameter pull line in each underground conduit.

G. Burial depths of conduits shall comply with the NEC (minimum).

H. Provide underground type plastic line markers: permanent, brightly colored, continuously printed plastic tape, intended for direct burial service, not less than 6 inches wide, reading “Caution Buried Electrical Line.” Install continuous line markers located directly over buried line at 6 inches above top of conduit, during back filling operation.

END OF SECTION

SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Electrical identification materials and devices required to comply with ANSI C2, NFPA 70, OSHA standards, and authorities having jurisdiction.

1.2 REFERENCES

A. American National Standards Institute (ANSI) Publications.

B. National Fire Protection Association (NFPA) Publications:
   1. 70 "National Electric Code"

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections:
   1. Product Data: For each electrical identification product indicated.

1.4 PRIOR APPROVAL

A. General:
   1. Catalog and manufacturer's numbers are for the purpose of establishing standards of quality and types of materials to be used. Products of other manufacturers may be used if equal in quality and design in the opinion of the Engineer and are specifically approved by the Engineer, in writing, 10 days prior to close of bidding.
   2. Any conflict arising from the use of substituted equipment shall be the responsibility of the supplier of that equipment. The contractor and his supplier shall bear all costs required to make equipment comply with the intent of the plans and specifications.

1.5 QUALITY ASSURANCE

A. Comply with ANSI C2.

B. Comply with NFPA 70.

C. Comply with ANSI A13.1 and NFPA 70 for color-coding.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Approved Manufacturers:
   1. Brady USA, Inc. (800-541-1686)
   2. Panduit corp. (800-777-3300)
   3. Seton Identification Products (800-571-2596)

2.2 RACEWAY AND CABLE LABELS

A. Comply with ANSI A13.1, Table 3, for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
   1. Color: Black letters on orange field.
   2. Legend: Indicates voltage

B. Pretensioned, Wraparound Plastic Sleeves: Flexible, preprinted, color-coded, acrylic band sized to suit the diameter of the line it identifies and arranged to stay in place by pretensioned gripping action when placed in position.

C. Colored Adhesive Tape: Self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

D. Underground-Line Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape.
   1. Not less than 6 inches wide by 4 mils thick.
   2. Compounded for permanent direct-burial service.
   3. Embedded continuous metallic strip or core.
   4. Printed legend indicating type of underground line.

E. Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.

F. Aluminum, Wraparound Marker Bands: Bands cut from 0.014-inch thick aluminum sheet, with stamped or embossed legend, and fitted with slots or ears for permanently securing around wire or cable jacket or around groups of conductors.

G. Plasticized Card-Stock Tags: Vinyl cloth with preprinted and field-printed legends. Orange background, unless otherwise indicated, with eyelet for fastener.

H. Aluminum-Faced, Card-Stock Tags: Weather-resistant, 18-point minimum card stock faced on both sides with embossable aluminum sheet, 0.002 inch thick, laminated with moisture-resistant acrylic adhesive, punched for fasteners, and preprinted with legends to suit each application.

2.3 NAMEPLATES AND SIGNS

A. Safety Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145.

B. Engraved Plastic Nameplates and Signs: Engraving stock, melamine plastic laminate, minimum 1/16 inch thick for signs up to 20 sq. in. and 1/8 inch thick for larger sizes.
   1. Engraved legend with black letters on white face.
   2. Punched or drilled for mechanical fasteners.

C. Baked-Enamel Signs for Interior Use: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for the application. 1/4-inch grommets in corners for mounting.

D. Exterior, Metal-Backed, Butyrate Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for the application. 1/4-inch grommets in corners for mounting.

E. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32, stainless-steel machine screws with nuts and flat and lock washers.

2.4 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon cable ties.
   1. Minimum Width: 3/16 inch.
   2. Tensile Strength: 50 lb minimum.
   3. Temperature Range: Minus 40 to plus 185 deg F.
   4. Color: According to color-coding.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Identification Materials and Devices: Install at locations for most convenient viewing without interference with operation and maintenance of equipment.

B. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations with corresponding designations in the Contract Documents or with those required by codes and standards. Use consistent designations throughout Project.

C. Sequence of Work: If identification is applied to surfaces that require finish, install identification after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before applying.

E. Caution Labels for Indoor Boxes and Enclosures for Power and Lighting: Install

pressure-sensitive, self-adhesive labels identifying system voltage with black letters on orange background. Install on exterior of door or cover.

F. Circuit Identification Labels on Boxes: Install labels externally.
   1. Exposed Boxes: Pressure-sensitive, self-adhesive plastic label on cover.
   2. Concealed Boxes: Plasticized card-stock tags.
   3. Labeling Legend: Permanent, waterproof listing of panel and circuit number or equivalent.

G. Paths of Underground Electrical Lines: During trench backfilling, for exterior underground power, control, signal, and communication lines, install continuous underground plastic line marker located directly above line at 6 to 8 inches below finished grade. Where width of multiple lines installed in a common trench or concrete envelope does not exceed 16 inches overall, use a single line marker. Install line marker for underground wiring, both direct-buried cables and cables in raceway.

H. Secondary Service, Feeder, and Branch-Circuit Conductors: Color-code throughout the secondary electrical system.
   1. Wire color code:
      a. Color code for 240/120V system shall be as follows:
         1) Phase A: Black
         2) Phase B: Red
         3) Neutral: White
         4) Ground: Green
      b. Color-code for 208/120V system shall be as follows:
         1) Phase A: Black
         2) Phase B: Red
         3) Phase C: Blue
         4) Neutral: White
         5) Ground: Green
      c. Color-code for 480/277V system shall be as follows:
         1) Phase A: Brown
         2) Phase B: Orange
         3) Phase C: Yellow
         4) Neutral: Gray
         5) Ground: Green with yellow stripe
   2. Factory apply color the entire length of conductors, except the following field-applied, color-coding methods may be used instead of factory-coded wire for sizes larger than No. 10 AWG:
      a. Colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Use 1-inch wide tape in colors specified. Adjust tape bands to avoid obscuring cable identification markings.
      b. Colored cable ties applied in groups of three ties of specified color to each wire at each terminal or splice point starting 3 inches from the terminal and spaced 3 inches apart. Apply with a special tool or pliers, tighten to a snug fit, and cut off excess length.

I. Power-Circuit Identification: Metal tags or aluminum, wraparound marker bands for cables, feeders, and power circuits in vaults, pull and junction boxes, manholes, and switchboard rooms.
   1. Legend: 1/4-inch steel letter and number stamping or embossing with legend corresponding to indicated circuit designations.
   2. Tag Fasteners: Nylon cable ties.
   3. Band Fasteners: Integral ears.

J. Apply identification to conductors as follows:
   1. Conductors to Be Extended in the Future: Indicate source and circuit numbers.
   2. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color-coding to identify circuits' voltage and phase.
   3. Multiple Control and Communication Circuits in the Same Enclosure: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color-coding, or cable marking tape.

K. Apply warning, caution, and instruction signs as follows:
   1. Warnings, Cautions, and Instructions: Install to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.
   2. Emergency Operation: Install engraved laminated signs with white legend on red background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.

L. Equipment Identification Labels: Engraved plastic laminate. Install on each unit of equipment, including central or master unit of each system. This includes power, lighting, communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Unless otherwise indicated, provide a single line of text with 1/2-inch high lettering on 1-1/2-inch high label; where two lines of text are required, use labels 2 inches high. Use white lettering on black field. Apply labels for each unit of the following categories of equipment using mechanical fasteners:
   1. Panelboards, electrical cabinets, and enclosures.
   2. Access doors and panels for concealed electrical items.
   3. Electrical switchgear and switchboards.
   4. Emergency system boxes and enclosures.
   5. Disconnect switches.
   6. Enclosed circuit breakers.
   7. Motor starters.
   8. Dimmers.
   9. Control devices.
   10. Telephone switching equipment.
   11. Label inside of all switch plates and cover plates with panel and circuit numbers.

END OF SECTION

SECTION 26 08 00

COMMISSIONING OF LIGHTING & CONTROL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Attention is directed to the printed form of Contract and General Conditions and Supplementary Conditions which are hereby made a part of this Section of the Specifications.

B. Commissioning: Commissioning (Cx) is a quality-oriented process for achieving, verifying, and documenting that the performance of facilities, systems, and assemblies meet the defined objectives and criteria set by the Owner.

C. Commissioning Team: The members of the Cx team consist of the owner's contracted commissioning authority (CxA), the owner's representative or construction manager (CM), the general OR prime contractor (GC), the architect (Arch) and the design engineers (Engs), the mechanical Contractors (MC), the electrical contractor (EC), the testing and balancing (TAB) contractor, the control contractor (CC), the facility operating staff, and any other subContractors or suppliers of equipment. The CxA directs and coordinates the project Cx activities and reports to the owner. All team members work together to fulfill their contracted responsibilities and meet the objectives of the contracted documents. Commissioning Shall:

1. Verify that applicable equipment and systems are installed according to the contract documents, manufacturer's recommendations, and industry accepted minimum standards and that they receive adequate operational checkout by installing Contractors.

2. Verify and document proper performance of equipment and systems through functional testing.

3. Verify that O&M documentation left on site is complete.

4. Verify that the owner's operating personnel are adequately trained.

D. The Cx process does not take away from or reduce the responsibility of the system designers or installing Contractors to provide a finished and fully functional product. Furthermore, it doesn't not remove any responsibilities, products or requirements of other specification sections. This includes provision for startup/programming of the lighting & control system by the installing contractor or manufacturer startup representative.

E. The general or electrical contractors are not required to provide the CxA. An independent, third-party commissioning agent has been retained by the State of Idaho. Though the contractor is not required to provide a commissioning agent, requirements for participation in the commissioning process are included in this specification.

1.2 DESCRIPTION OF WORK

A. The work of this Section shall include and provide all labor, tools, materials and equipment necessary for the CxA to verify installation and performance of the Lighting & Control systems.

1.3 REFERENCE STANDARDS

A. ASHRAE Standard 202-2018

B. IECC 2018

1.4 DEFINITIONS

A. Commissioning Plan: The detailed process of checking and testing procedures, sequences of events, schedules, staffing plans, and management or administrative procedures required to provide a comprehensive coordinated approach for commissioning the systems and equipment described herein.

B. CxA: Commissioning Authority. The main point of contact for the commissioning process and third party technical representative of the owner. The Commissioning Authority will manage all commissioning activities on behalf of the Owner and will serve as the Owner's agent in review and approval of commissioning related services.

C. Commissioning Procedures: A series of checks, tests, and operational procedures, applied in specific sequences, to each system or equipment component to be commissioned and intended to demonstrate full system installation, performance, and functionality, in accordance with the design intent. The term "procedures" shall be used throughout this specification and the Project Commissioning Plan in reference to these checking, testing, and operational procedures.

D. Pre-Functional Test: A test, or tests, of the static function and operation of equipment and systems using manual (direct observation) by the installing contractor prior, during and post-equipment startup. Systems Pre-Functional Performance Testing is meant to verify the as-built systems ability to operate trouble free in at least a limited fashion prior to TAB and Systems Functional Performance testing.

E. Functional Performance Test: A test, or tests, of the dynamic function and operation of equipment and systems using manual (direct observation) or monitoring methods meant to commence following the completion of startup/programing and Systems Pre-Functional Testing. Systems Functional Performance Testing is the dynamic testing of systems (rather than just components) under full operation (e.g., the chiller pump is tested interactively with the chiller functions to see if the pump ramps

up and down to maintain the differential pressure setpoint) performed by the Commissioning Agent with support from the contractor as needed. Systems are tested under various modes, such as during normal occupied, unoccupied or emergency modes. The systems are run through all the control system's sequences of operation and components are verified to be responding as the sequences state. Manufacturer startup and control system checkout is not considered Systems Functional Performance Testing. The Commissioning Agent develops the Systems Functional Performance Test Procedures in a sequential written form, coordinates, witnesses, and documents the actual testing. Systems Functional Performance Tests are performed after startups, control systems are complete and operational, TAB functions and Pre-Functional Checklists are complete.

F. Pre-Functional Checklist: A list of items in the form of s checklist provided by the Commissioning Agent to the Contractor that require inspection and elementary component tests conducted to verify proper installation of equipment. The contractor is required to perform this work, populate checklist forms and submit them to the Commissioning Authority prior to scheduling functional testing. Pre-Functional Checklists are primarily static inspections and procedures to prepare the equipment or system for initial operation. However, some Pre-Functional Checklist items entail simple testing of the function of a component, a piece of equipment or system which may have been completed during manufacturer startup and programming. The term "Pre-Functional" refers to before Systems Functional Performance Testing. Pre-Functional Checklists augment and are combined with the manufacturer's startup checklist and the Contractor's Quality Control checklists.

G. Commissioning Plan: The detailed process of checking and testing procedures, sequences of events, schedules, staffing plans, and management or administrative procedures required to provide a comprehensive coordinated approach for commissioning the systems and equipment described herein.

H. Commissioning Authority: The Commissioning Representative of the Owner. The Commissioning Authority will manage all commissioning activities on behalf of the Owner and will serve as the Owner's agent in review and approval of commissioning related services.

I. System, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.5 INTENT

A. It is the intention of this Specification is to require the Contractors performing work to cooperate with the owner provided, third-party CxA, to furnish labor and equipment and measuring devices as needed, to perform required measurements and tests to verify that the installed equipment and systems are performing in accordance with the construction documents.

B. The CxA is not responsible for design concept, design criteria, compliance with codes, design or general construction scheduling, cost estimating or construction management.

C. HVAC system installation, start-up, preparation of O&M manuals, and operator training are the responsibility of the HVAC Contractor, with coordination by the General Contractor, Construction Manager or other entity acting under the requirements of Division 1. Observation, verification and Cx are the responsibility of the CxA who is to be assisted by installing Contractors in system operation as needed. The Cx process does not relieve Contractors from the obligations to complete all portions of work in a satisfactory and fully operational manner, nor does Cx remove any obligation the trades have for operation and maintenance manuals and training.

1.6 ELECTRICAL CONTRACTOR'S RESPONSIBILITIES

A. Cx, Pre-Functional and Functional testing as defined by ASHRAE standard 202-2018 are mandatory requirements of this project. All equipment and systems installed in connection with the section listed above shall be put in operation in the presence of duly authorized representatives with 48-hour notice given to the CxA.

B. All applicable equipment submittals shall be forwarded to the CxA for review.

C. No Functional Testing shall commence until the completion and submission of the manufacturer startup checklists, Test and Balance Report and populated pre-functional checklists to the CxA. The CxA will provide blank pre-functional testing forms for the contractor to populate. Pre-functional testing forms shall be provided to the CxA in submittal form.

D. Perform manufacturer startup, programming and checkout as required by division 26 specification. Retain trained manufacturer representatives as required for startup, programming and initial checkout.

E. List and clearly identify on the as-built drawings the locations of all controllers, sensors and fixtures.

F. Prepare a preliminary schedule for manufacturer startup and programming completion for use by the CxA. Coordinate this schedule with the GC as appropriate.

G. Attend Cx scoping meetings and other meetings necessary to facilitate the Cx process. See section 019114 for estimated time commitment information.

H. Provide a copy of the O&M manuals and submittals of commissioned equipment, through normal channels, together during equipment submittals to the CxA for review and approval. See this specification section for additional information and requirements for the O&M manuals.

I. Contractors shall assist (along with the design engineers) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.

J. Review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.

K. Develop a full start-up and initial checkout plan using manufacturer's start-up procedures and populate the Pre-Functional Checklists (PFTs) from the CxA for all commissioned equipment. Submit to CxA for review and approval prior to startup.

L. During the startup and initial checkout process, execute the MEP-related portions of the PFTs for all commissioned equipment. Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the CxA.

M. Address current outstanding punch list items before functional testing.

N. Complete Prefunctional Test Checklists (PFTs) provided by the CxA and return these to the CxA. After the contractors have completed the PFTs and returned them to the CxA, the CxA will back-check a percentage for accuracy. If the actual field work is not in agreement with the sheets, the contractor will be required to make corrections at their expense. After completion of corrective work, the CxA will review another section of the work and check for agreement with the checklists. The contractor(s) will be back charged for this, and all additional, checks required to verify checklists and complete the prefunctional phase of commissioning.

O. Provide access for equipment to be tested, such as removing ceiling tiles.

P. Provide skilled technicians to execute starting of equipment and to execute the functional performance tests as requested by the CxA. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem solving.

Q. Provide skilled technicians to assist with functional performance testing under the direction of the CxA for specified equipment outlined in the Cx Plan. Assist the CxA in interpreting the monitoring data, as necessary.

R. Correct deficiencies (differences between specified and observed performance). The CxA will provide one (1) functional retest of commissioned equipment at no additional charge to the contractor(s). If repeated failures of the equipment and/or system require retest beyond the first retest, the contractor(s) will be back charged for the time of the CxA required to complete the additional retesting.

S. Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions. Provide assistance, cooperate and provide required materials to others as directed by the GC (and CxA) in the compilation of the O&M manuals. Prepare draft versions of the O&M Manual for use as the training syllabus.

T. During construction, maintain as-built red-line drawings for all drawings and final CAD as-builts for contractor-generated coordination drawings. Update after completion of Cx (excluding deferred testing).

U. Provide Training Plan and training of the Owner's operating staff using expert qualified personnel, as specified. Use the draft O&M manual as the training manual.

V. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.

W. Attend Cx coordination meetings and provided assistance and cooperate in the preparation of a Cx schedule with the GC and CxA.

X. Cx Tasks shall be performed by the same personnel who were involved in the installation and are familiar with the equipment.

Y. During the Warranty Period execute seasonal or deferred functional performance testing, witnessed by the CxA, according to the specifications and correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

1.7 CxA'S RESPONSIBILITIES

A. Provide Project-specific construction pre-functional checklists and commissioning process test procedures for actual lighting and controls, assemblies, equipment, and components to be furnished and installed as part of the construction contract.

B. Develop protocol and perform functional testing.

C. Provide test data, inspection reports, and summary commissioning report

D. Produce the commissioning record

E. Review of manufacturer startup documentation

1.8 COMMISSIONING DOCUMENTATION

A. Provide the following information to the CxA for inclusion in the commissioning plan:

1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.

2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.

3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for Electrical systems, assemblies, equipment, and components to be verified and tested.

4. Certificates of completion/readiness and completed Pre-functional Test forms certifying that installation, prestart checks, and startup procedures have been completed and that systems, subsystems, equipment, and associated controls are ready for testing.

5. For lighting or other occupancy/vacancy sensors, submit as-built, as-installed catalog cuts sheets showing final settings of sensors (time delays, sensitivity, dipswitch positions, etc.).

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. Electrical subcontractor shall furnish all the equipment and labor to perform the systems and equipment installed under their section.

B. Stand-alone datalogging equipment shall be provided by the CxA as needed.

C. Lighting control systems datalogging equipment and software can be used for Cx as the discretion of the CxA and shall become the property of the Owner.

D. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications. All equipment shall be calibrated according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates readily available where applicable.

PART 3 - EXECUTION

3.1 SUBMITTALS

A. Contractors shall provide submittal documentation for systems and equipment to be commissioned indicated herein and in the Cx Plan.

B. Contractor shall provide populated manufacturer startup checklists

C. Contractor shall provide populated prefunctional checklists.

3.2 PRE-COMMISSIONING WORK SESSION & KICKOFF MEETING

A. The GC shall schedule and chair a pre-commissioning work session to review the CxA's developing Commissioning Plan. The work session shall be held prior to lighting & control system rough-in.

B. The work session shall be held at the Contractor's principle place of business or at the job site. The GC, CxA, appropriate subcontractors and representatives of the owner shall be scheduled for attendance as a minimum by the GC. Sub-contractor representatives of the principle trades involved in the commissioning process should also be in attendance and may be scheduled for attendance at the discretion of the CxM.

C. Lighting installer and/or electrical contractor(s) shall participate in both the work session and kickoff meeting.

3.3 TESTING PREPARATION BY INSTALLING CONTRACTOR

A. Contractor(s) shall follow the start-up and initial checkout procedures required by the manufacturer, those listed in Part 3 listed in the Responsibilities list in this section and in the Cx Plan. Division 22, 23 and 26 has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents and manufacturer requirements. The Cx procedures and pre-functional and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the CxA, GC or Owner.

B. Certify that Lighting & Control systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents. Manufacturer startup shall be complete prior to any testing.

C. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

D. Inspect and verify the functionality of each fixture and/or device as required on pre-functional checklists.

E. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

3.4 PRE-FUNCTIONAL TESTING

A. Prior to the beginning of the commissioning and testing specified under this section, the lighting and/or electrical subcontractor adjust and check operation and performance of the systems and equipment installed under their respective sections.

B. At the discretion of the CxA the sub systems may be required to be tested prior completion of the entire system.

C. Provide populated forms to the CxA in submittal form.

D. Without limiting other work, the following work shall be performed:

1. Verify and document that the systems and equipment are installed and functioning in accordance with the OPR and contract documents. The as-built drawings and operating manuals reflect the as built conditions.

2. The systems shall be started and their performance shall be checked and compared with the manufacturers requirements as well as design documents.

3. Blank Pre-functional checklists shall be provided by the CxA.

4. Any system or equipment which is does not pass manufacturer startup requirements and Pre-functional testing shall be repaired and replaced at no cost to the owner with the exception of any existing equipment reused or repurposed for this project. The contractor shall retest the system at their own cost until the manufacturers startup requirements and pre-functional testing criteria are met.

3.5 FUNCTIONAL TESTING

A. After review and acceptance of the manufacturer startup forms and pre-functional checklists, the CxA will schedule dates to begin functional testing.

B. Functional testing is intended to begin upon completion of a system installation, startup and pre-functional testing. Functional testing may proceed prior to the completion of systems or sub-systems at the discretion of the CxA and Owner. Beginning system testing before full completion does not relieve the Contractor from fully completing the system, including all PFTs as soon as possible.

C. Procedure Acceptance

1. On-Site Conditional Acceptance

2. Upon satisfactory completion of each commissioning procedure and completion of the procedure close-out meeting, the CxA shall provide conditional acceptance of the procedure.

3. Conditional acceptance shall indicate that the related installation work checked by the procedure and the related performance verified by the procedure is satisfactory, and that the required procedure has been completed, only.

4. Conditional acceptance shall not imply that the equipment and systems involved with the procedure are fully approved and have been provided with final acceptance. Conditional acceptance shall additionally be subject to all notes and comments included in the field notes or test forms, and subject to the satisfactory demonstration that all associated pre-testing, special testing, special testing reports, or alignment reports have been fully completed.

5. Conditional acceptance shall be indicated by the signature of the CxA on the functional testing form.

D. On-Site Procedure Rejection

1. The CxA shall have the authority to reject a procedure in its entirety or to cause the procedure to be stopped if in the opinion of the CxA, any of the following conditions exist:

   a. The pre-commissioning or kickoff meetings are incomplete.

   b. Appropriate or sufficient contractor staff is not available or required commissioning representatives are not present.

   c. Required pre-testing or report data, such as point-to-point control verifications, alignment reports, and trend log data is not available or is incomplete.

   d. The installation is insufficient or incomplete as required for the procedure or not in compliance with the Contract Documents.

   e. Numerous checks or tests fail or cannot be accomplished.

   f. Installation and/or operation of equipment or systems beyond or in advance of the commissioning requirements.

g. Installation, operation, or commissioning not in compliance with the sequencing requirements.

h. Indication of improper maintenance or operation.

i. Inadequate instrumentation or tools.

2. The CxA shall additionally reject a procedure and require the equipment operation or procedure to be stopped if in the opinion of the CxA unsafe conditions to either staff or equipment exist. Consideration of safety issues by the CxA shall not in any way relieve the Contractor from his sole responsibility for job site safety and protection of the equipment.

3. Direction to stop the procedure or halt the operation of equipment will be given verbally. Upon notification the Contractor shall immediately stop the procedure and restore the system or equipment to a safe condition.

4. At the discretion of the CxA, the Contractor may be afforded the opportunity to correct the conditions indicated by the CxA and resume the procedure.

5. If in the opinion of the CxA corrections cannot be implemented in a satisfactory manner, within the scheduled time available for the procedure and with sufficient time available to complete the procedure, the procedure shall be stopped and rescheduled by the CxM. The CxA shall provide the CxM with written notification of procedure rejection stating the cause of the action.

6. The Contractor shall be liable for all actual costs associated with the required attendance by the CxA, the Owner's and A/E's commissioning representatives, and required outside agents, resulting from rejected procedure.

7. Actual costs shall include:

a. Cost for the CxA and for each Owner's and A/E's commissioning representative, which are comprised of contractual billing rate as defined in the respective organization's agreement for such work, including overhead and profit. For CxA and A/E's commissioning representatives, these rates may be found in the A/E schedule for additional services.

b. Travel-related expenses for the CxA and for each Owner's or A/E's commissioning representative, where such staff is required to be in attendance and not headquartered within the city limits, which are comprised of compensation for actual travel time, with an established minimum of 5 hours, and mileage rates, billed at the prevailing national government rate.

c. Costs assessed for required outside agents, contractors, or specialists employed by the Owner or A/E at the actual contractual billing rates as defined in the respective organization's agreement for such work.

d. Equipment rentals, special tools, and related material fees associated with the participation of contracted outside organizations and specialists.

E. The costs assessed will be documented by the CxA and may be deducted from the Contractor's fees or progress payments at the time of occurrence

3.6 FINAL ACCEPTANCE

A. Final acceptance will be contingent upon satisfactory completion of all commissioning tasks and submittals, with final review and approval by the Commissioning Authority.

B. Where specific components, equipment, or system elements are unable to comply with the specified requirements due to improper or incomplete installation, product defect, or failure of a device to perform to the manufacturer's published or advertised capabilities, final acceptance will be contingent on repair, replacement, and correction of the deficiencies by the Contractor and satisfactory completion of the commissioning procedures.

C. Where specific components, equipment, or system elements are demonstrated to comply with the specified requirements and perform to the manufacturer's published or advertised capabilities, but are demonstrated not to provide the performance as required by the Contract Documents and the commissioning procedures, disposition of the issue and/or related modifications shall be provided as directed by the Architect. Final acceptance shall be contingent on the completion of any resulting correction work and related commissioning requirements determined as necessary in final disposition of the issue.

D. Upon satisfactory completion of all commissioning work and resolution of all related issues, the CxA shall provide the Owner, Contractor, and the Architect with a final report documenting recommendation for final acceptance. Recommendation for final acceptance by the CxA shall indicate that in the opinion of the CxA, and as demonstrated within the extent and scope of the commissioning process, the equipment and systems have been installed in compliance with, and function as required by the Contract Documents.

E. The Owner may accept the recommendation of the CxA and provide final acceptance by providing the appropriate authorized signature and by providing copies of the signed acceptance to all parties involved. The Owner's final acceptance of the commissioning work shall indicate that Owner accepts that the systems and equipment, as demonstrated within the extent and scope of the commissioning process, have been installed in compliance with, and function as required by, the Contract Documents. The Owner's acceptance shall not constitute agreement that all contractual obligations are fulfilled and does not constitute final acceptance of the project under the terms and conditions of the Contract Documents.

END OF SECTION 260800

SECTION 26 2200

DRY-TYPE TRANSFORMERS (1000 V AND LESS)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes dry-type distribution and specialty transformers rated 1000 V and less.

1.3 SUBMITTALS

A. Product Data: Include data on features, components, ratings, and performance for each type of transformer specified. Include dimensioned plans, sections, and elevation views. Show minimum clearances and installed devices and features.

B. Wiring Diagrams: Detail wiring and identify terminals for tap changing and connecting field-installed wiring.

C. Factory Test Reports: Copy of manufacturer's design and routine factory tests required by referenced standards.

D. Sound-Level Test Reports: Copy of manufacturer's sound-level tests applicable to equipment for this project.

E. Maintenance Data: For transformers.

1.4 QUALITY ASSURANCE

A. Listing and Labeling: Provide transformers specified in this section that are listed and labeled as defined in the NEC.

B. Equipment shall conform or exceed requirements of NEMA, ANSI Standard C89.2 for dry-type transformers for general applications.

C. Comply with the NEC.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:
   1. Cutler-Hammer/Eaton Corp.
   2. GE Electrical Distribution & Control.
   3. Square D; Groupe Schneider.
   4. Siemens
   5. Or approved equal.

2.2 TRANSFORMERS, GENERAL

A. Description: Factory-assembled and -tested, air-cooled units of types specified, designed for 60-Hz service.

B. Cores: Grain-oriented, nonaging silicon steel.

C. Coils: Continuous windings without splices, except for taps.

D. Internal Coil Connections: Brazed or pressure type.

E. Enclosure: Class complies with NEMA 250 for the environment in which installed.

F. Low-Sound-Level Units: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

2.3 GENERAL-PURPOSE DISTRIBUTION AND POWER TRANSFORMERS

A. Comply with NEMA ST 20 and list and label as complying with UL 1561.

B. Cores: One leg per phase.

C. Windings: One coil per phase in primary and secondary.

D. Electrical ratings:
   1. Primary winding voltage: 480 volts, 3 phase, delta.
   2. Secondary winding voltage: 120/208 volts, 3 phase grounded wye.
   3. KVA rating: As indicated on drawings.

E. Enclosure: Indoor, ventilated.

F. Temperature classification:
   1. Winding temperature rise shall be 150 degrees C in accordance with UL specification 506 with insulation Class 220 degree Celsius.

G. Load rating:

1. Transformer shall be capable of operating at 100% of nameplate rating continuously while in an ambient temperature not exceeding 40 degrees C.
2. Transformer shall meet the daily overload requirements of ANSI Standard C57.96.

H. Taps: For transformers 3 kVA and larger, full-capacity taps in high-voltage windings are as follows:
1. Taps, 3 through 10 kVA: Two 5-percent taps below rated high voltage.
2. Taps, 15 through 500 kVA: Six 2.5-percent taps, 2 above and 4 below rated high voltage.
3. Taps, 750 kVA and Above: Four 2.5-percent taps, 2 above and 2 below rated high voltage.

I. K-Factor Rating: Transformers indicated to be K-factor rated are listed to comply with UL 1561 requirements for nonsinusoidal load current handling capability to the degree defined by the designated K-factor.
1. Transformer design prevents overheating when carrying full load with harmonic content corresponding to the designated K-factor.
2. Nameplate states the designated K-factor of the transformer.

J. Vibration Isolation:
1. Provide neoprene rubber pads to isolate core and coil assembly from transformer enclosure.

K. Wall-Mounting Brackets: Manufacturer's standard brackets for transformers up to 75 kVA.

2.4 BUCK-BOOST TRANSFORMERS

A. Units comply with NEMA ST 1 and are listed and labeled as complying with UL 506 or UL 1561.

B. Description: Self-cooled dry type, rated for continuous duty, and connected as autotransformers to provide the percentage of buck or boost indicated.

2.5 CONTROL AND SIGNAL TRANSFORMERS

A. Units comply with NEMA ST 1 and are listed and labeled as complying with UL 506.

B. Ratings: Continuous duty. If rating is not indicated, provide capacity exceeding peak load by 50 percent minimum.

C. Description: Self-cooled, 2 windings.

2.6 FINISHES

A. Indoor Units: Manufacturer's standard paint over corrosion-resistant pretreatment and primer.

2.7 SOURCE QUALITY CONTROL

A. Factory Tests: Design and routine tests comply with referenced standards.

B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this project if specified sound levels are below standard ratings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with safety requirements of IEEE C2.

B. Arrange equipment to provide adequate spacing for access and for circulation of cooling air.

C. Anchor transformer securely with minimum ½" diameter bolts. Strength of bolts used to secure the transformer shall be sufficient to resist shear and uplift produced by a force equal to one half of the equipment mass applied horizontally at the center of gravity.

D. Provide 1" thick resiliency pads to isolate transformer from floor or platform, Korfund "Elasto Rib" or equal.

E. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.

F. The grounding conductor for each transformer shall be routed back to the Main Grounding Bar used for the building ground system.

3.2 GROUNDING

A. Separately Derived Systems: Comply with the NEC requirements for connecting to grounding electrodes and for bonding to metallic piping near the transformer.

B. Comply with Section 260526 - Grounding for materials and installation requirements.

3.3 CONNECTIONS

A. Use flexible conduits at least 24" long for electrical connections.

3.4 IDENTIFICATION

A. Provide engraved lamacoid nameplate for each transformer.

3.5 FIELD QUALITY CONTROL

A. Test Objectives: To ensure transformer is operational within industry and manufacturer's tolerances, is installed according to the contract documents, and is suitable for energizing.

B. Tests: Include the following minimum inspections and tests according to manufacturer's written instructions. Comply with IEEE C57.12.91 for test methods and data correction factors.
   1. Inspect accessible components for cleanliness, mechanical and electrical integrity, and damage or deterioration. Verify that temporary shipping bracing has been removed. Include internal inspection through access panels and covers.
   2. Inspect bolted electrical connections for tightness according to manufacturer's published torque values.

C. Test Failures: Compare test results with specified performance or manufacturer's data. Correct deficiencies identified by tests and retest. Verify that transformers meet specified requirements.

3.6 CLEANING

A. On completion of installation, inspect components. Remove paint splatters and other spots, dirt, and debris. Repair scratches and mars on finish to match original finish. Clean components internally using methods and materials recommended by manufacturer.

3.7 ADJUSTING

A. After installing and cleaning, touch up scratches and mars on finish to match original finish.

B. Adjust transformer taps to provide optimum voltage conditions at utilization equipment throughout normal operating cycle of facility. Record primary and secondary voltages and tap settings and submit to owner.

C. Adjust buck-boost transformer connections to provide optimum voltage conditions at utilization equipment throughout normal operating cycle of facility.

END OF SECTION

SECTION 26 24 00

DISTRIBUTION SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This section includes distribution switchboards.

B. Related section – Section 26 0501 Field Test and Operational Check.

1.3 REFERENCES

A. FS W-C-375 - Circuit Breakers, Molded Case, Branch Circuit and Service.

B. NEMA AB 1 - Molded Case Circuit Breakers.

C. NEMA PB 2 - Dead Front Distribution Switchboards.

D. NEMA PB 2.1 - Instructions for Safe Handling, Installation, Operation and Maintenance of Deadfront Switchboards Rated 600 Volts or Less.

1.4 SUBMITTALS

A. Submit product data and shop drawings.

B. Include front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars per phase, neutral, and ground; switchboard instrument details; instructions for handling and installation of switchboard; and electrical characteristics including voltage, frame size and trip ratings, withstand ratings, and time-current curves of all equipment and components.

1.5 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data.

1.6 DELIVERY, STORAGE, AND HANDLING:

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle in accordance with NEMA PB2.1 and manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.7 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

1.8 SPARE PARTS

A. Keys: Furnish 3 each to owner.

B. Fuses: Furnish to owner 3 spare fuses of each type and rating installed.

C. Fuse Pullers: Furnish one fuse puller to owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. General Electric, Cutler-Hammer, Square D or approved equal.

2.2 SWITCHBOARD CONSTRUCTION AND RATINGS

A. Factory-assembled, dead front, metal-enclosed, and self-supporting switchboard and complete from incoming line terminals to load-side terminations. Provide lugs appropriate for conductors used.

B. Switchboard electrical ratings and configurations as shown on drawings. The short circuit current rating indicated should be an integrated rating of switchboard and its devices.

C. Line and Load Terminations: Accessible from the front only of the switchboard, suitable

for the conductor materials used.

D. Bus Material: Copper sized in accordance with NEMA PB 2.

E. Bus Connections: Bolted, accessible from front for maintenance.

F. Enclosure shall be NEMA PB 2 Type 1 - General Purpose. Sections shall align at front and rear.

G. Switchboard Height: 90 inches, excluding floor sills, lifting members and pull boxes.

H. Finish: Manufacturer's standard light gray enamel over external surfaces. Coat internal surfaces with minimum one coat corrosion-resisting paint, or plate with cadmium or zinc.

I. Future Provisions: Fully equip spaces for future devices with bussing and bus connections, suitably insulated and braced for short circuit currents. Continuous current rating as indicated on drawings.

2.3 MOLDED CASE CIRCUIT BREAKERS

A. Common molded case circuit breaker characteristics
1. Main circuit breaker device shall have shut trip device for power quality monitor trip during phase failure.
2. Surge protection device to be included on main circuit breaker – 100ka.
3. Circuit breakers shall be constructed in accordance with the following standards:
   a. UL 489
   b. NEMA AB1
   c. CSA 22.5, No. 5
   d. Federal Specification W-C-375B/GEN
   e. IEC157-1
   f. BS4752
4. Circuit breakers shall be constructed using glass reinforced insulating material providing superior dielectric strength. Current carrying components shall be completely isolated from the handle and the accessory mounting area.
5. Circuit breakers shall have an over center, trip free, toggle operating mechanism which will provide quick-make, quick-break contact action.
6. The circuit breaker shall have common tripping of all poles.
7. The circuit breaker handle shall reside in a "TRIPPED" position midpoint between "ON" and "OFF" to provide local trip indication.
8. Circuit breaker escutcheon shall be clearly marked "ON" and "OFF" in addition to providing International I/O markings.
9. The maximum continuous current rating and UL and IEC certification standards with applicable voltage systems and corresponding AIC ratings shall be clearly marked on face of circuit breaker.
10. Circuit breakers shall have high interrupting ratings.
11. Circuit breakers shall be factory sealed and shall have date code on face of circuit breaker.
12. Circuit breaker/circuit breaker combinations for series connected interrupting

ratings shall be listed by UL as recognized component combinations. Any series rated combination used shall be marked on the end use equipment along with the statement “Caution - Series Rated System”.

13. Manufacturer shall provide time/current characteristic trip curves and Ip & I2t let through curves for true current limiting circuit breakers only for each type of Circuit breaker.
14. All circuit breakers shall be UL listed for reverse connection without restrictive line and load markings and be suitable for mounting in any position.
15. Circuit breaker handle accessories shall provide provisions for locking handle in the “ON” or “OFF” position.
16. Circuit breakers shall be fixed construction with factory installed mechanical lugs.
17. All lugs shall be UL listed to accept solid and/or stranded copper and aluminum conductors. Lugs shall be suitable for 75°C rated wire.
18. All circuit breakers shall be UL listed to accept field installable/removable mechanical type or compression type lugs. Lug body shall be bolted in place, snap in design not acceptable.
19. All circuit breakers shall be capable of accepting line and/or load bus connections.

B. Thermal magnetic
1. Circuit breakers shall have a permanent trip unit containing individual thermal and magnetic trip elements in each pole providing inverse time delay and instantaneous circuit protection.
2. All circuit breakers shall have factory preset and sealed thermal trip elements. The thermal trip system shall be RMS sensing and thermally responsive to protect circuit conductors in a 400°C ambient temperature.
3. Two and three pole circuit breakers shall have an internal common trip crossbar to provide simultaneous tripping of all poles. Circuit breaker frame sizes above 100 amperes shall have a single magnetic trip adjustment located on the front of the circuit breaker which allows the user to simultaneously select the desired instantaneous trip level of all poles.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install switchboard in locations shown on Drawings, in accordance with manufacturer’s written instructions and NEMA PB 2.1.

B. Tighten accessible bus connections and mechanical fasteners after placing switchboard.

C. Provide 2” high concrete leveling pad under switchboard. Dimension 6” larger than footprint of equipment. Anchor to pad with ½” anchor bolts.

3.2 FIELD QUALITY CONTROL

A. Testing: Refer to Section 16040 – Field Test and Operational Check.

3.3 IDENTIFICATION

A. Provide engraved lamacoid nameplate for the switchboard and each component.

B. Provide warning signs.

3.4 ADJUSTING AND CLEANING

A. Set field-adjustable switches and circuit breaker trip ranges.

B. Adjust all operating mechanisms for free mechanical movement.

C. On completion of installation, inspect interior and exterior of switchboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION

SECTION 26 24 13

MAIN SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including agreement between the owner and CM/GC and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This section includes main switchboards.

B. Related sections:
   1. Section 260501 - Field Test and Operational Check.
   2. Section 260526 - Grounding.

1.3 REFERENCES

A. FS W-C-375 - Circuit Breakers, Molded Case, Branch Circuit and Service.

B. NEMA AB 1 - Molded Case Circuit Breakers.

C. NEMA PB 2 - Dead Front Distribution Switchboards.

D. NEMA PB 2.1 - Instructions for Safe Handling, Installation, Operation and Maintenance of Deadfront Switchboards Rated 600 Volts or Less.

1.4 SUBMITTALS

A. Product Data: For each type of switchboard, overcurrent protective device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Include front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars per phase, neutral, and ground; switchboard instrument details; instructions for handling and installation of switchboard; and electrical characteristics including voltage, frame size and trip ratings, withstand ratings, one line and wiring diagrams, and time-current curves of all equipment and components.

C. Field test reports – See Section 260501.

1.5 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data. Include the following:
1. Routine maintenance requirements for switchboards and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
3. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.6 DELIVERY, STORAGE, AND HANDLING:

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle in accordance with NEMA PB2.1 and manufacturer’s written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.7 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

1.8 SPARE PARTS

A. Keys: Furnish 3 each to owner.

B. Fuses: Furnish to owner 3 spare fuses of each type and rating installed.

C. Fuse Pullers: Furnish one fuse puller to owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. General Electric, Cutler-Hammer, Siemens, Square D Co.; Schneider Electric Brands,

or approved equal.

2.2 SWITCHBOARD CONSTRUCTION AND RATINGS:

A. Factory-assembled, dead front, metal-enclosed, and self-supporting switchboard assembly conforming to NEMA PB 2, and complete from incoming line terminals to load-side terminations. Provide lugs appropriate for conductors used.

B. Switchboard electrical ratings and configurations as shown on Drawings.

C. Equipment shall be fully rated to interrupt symmetrical short-circuit current available at terminals or the rating indicated on the plans, whichever is higher. Series rating is not acceptable unless specifically indicated on the plans.

D. Line and Load Terminations: Accessible from the front of the switchboard, suitable for the conductor materials used.

E. Bus Material: Copper sized in accordance with NEMA PB 2.

F. Bus Arrangement: Use A-B-C sequence in left-to-right, top-to-bottom, and front-to-rear arrangement throughout.

G. Bus Connections: Bolted, accessible from front or rear for maintenance.

H. Enclosure shall be NEMA PB 2 Type 1 - General Purpose. Sections shall align at front and rear. Provide NEMA 3R Enclosure when indicated on plans.

I. Switchboard Height (NEMA 1) : 90 inches, excluding floor sills, lifting members and pull boxes.

J. Finish: Manufacturer’s standard light gray enamel over external surfaces. Coat internal surfaces with minimum one coat corrosion resisting paint, or plate with cadmium or zinc.

K. Future Provisions: Fully equip spaces for future devices with bussing and bus connections, suitably insulated and braced for short circuit currents. Continuous current rating as indicated on Drawings.

2.3 SWITCHING AND OVERCURRENT PROTECTIVE DEVICES-

A. Main Circuit Breaker Assemblies:
1. Main Circuit breakers (unless otherwise indicated on plans) shall be insulated case type as indicated on plans with temperature insensitive, solid state trips, current sensors and solid state logic circuit integral with the frame. All circuit

breakers shall be of same design for over-current and ground fault trip coordination.

2. All Main Circuit Breakers rated for 1200 Amp or higher shall have the following features:
   a. UL listed for 80 percent load application unless otherwise indicated on plans as 100% rated.
   b. Adjustable [L] Long time time-delay and ampere setting.
   c. Adjustable [S] Short time-delay and pick-up.
   d. Adjustable [I] Instantaneous trip.
   e. Adjustable [R] Reduced Energy Let-Through (RELT) Instantaneous trip. This feature shall be provided on breakers to provide a temporary setting for the instantaneous trip setting of the breaker. Setting shall be adjustable down to 1.5X of the rating plug and shall be enabled through a switch mounted on front of the switchboard. The switch shall be combined with an indicating light that positively indicates that the RELT is enabled or disabled.
   f. For 277/480Y systems rated 1000 Amp or higher - Adjustable [G] Ground fault pick-up and delay is required.
   g. Where Indicated special zone control interlocking for main breaker and future main and tie breaker of double-ended substation switchboard.
   h. Short circuit, overload and ground fault trip indicators.
   i. Trip device of circuit breakers shall be of the same type for tripping coordination and shall allow for the UL listed field installation of internal accessories (Auxiliary Switch, Shunt Trip, Undervoltage release, Bell Alarm Switch) without removal of cover to install. Breaker shall include Accessories as indicated on plans.
   j. Circuit breaker handle accessories shall provide provisions for locking handle in the ‘ON’ or ‘ OFF’ position.

B. ALL Feeder Breaker Assemblies 1200 Amp and above:
   1. 1. Feeder Circuit breakers 1200 Amp may be Molded Case or Individually Mounted, 1600 Amp and above shall be Insulated Case with temperature insensitive, solid state trips, current sensors and solid state logic circuit integral with the frame. All circuit breakers shall be of same design for over-current and ground fault trip coordination. The Circuit breakers shall have the following features:
      a. UL listed for 80 percent load application unless otherwise indicated on plans as 100% rated.
      b. Adjustable [L] Long time time-delay and ampere setting.
      c. Adjustable [S] Short time-delay and pick-up.
      d. Adjustable [I] Instantaneous trip.
      e. Adjustable [G] Ground fault pick-up and delay where indicated or required be NEC.
      f. Adjustable [R] Reduced Entergy Let-Through (RELT) Instantaneous trip. This feature shall be provided on breakers to provide a temporary setting for the instantaneous trip setting of the breaker. Setting shall be adjustable down to 1.5X of the rating plug and shall be enabled through a switch mounted on front of the switchboard. The switch shall be combined with an indicating light that positively indicates that the RELT is enabled or disabled.
      g. Where Indicated special zone control interlocking for main breaker and future

main and tie breaker of double-ended substation switchboard.
h. Short circuit, overload and ground fault trip indicators.

D. Feeder Circuit Breaker Assemblies below 1200 Amp:
1. Feeder Circuit breakers below 1200 Amp shall be digital solid state true RMS sensing Molded Case Circuit Breakers with temperature insensitive, solid state trips, current sensors and solid state logic circuit integral with the frame. All circuit breakers shall be of same design for over-current and ground fault trip coordination. The Circuit Breakers shall have the following minimum features:
a. UL listed for 80 percent load application unless otherwise indicated on plans.
b. Long time pickup (ampere setting) determined by interchangeable rating plug .
c. Adjustable instantaneous with short time tracking function.
d. Circuit Breaker shall allow the UL listed field installation internal accessories (Auxiliary Switch, Shunt Trip, Undervoltage release, Bell Alarm Switch) without removal of cover to install. Circuit Breaker shall include Accessories as indicated on plans.
e. Circuit breaker handle accessories shall provide provisions for locking handle in the ‘ON’ or ‘OFF’ position
2. Where specifically indicated or required by NEC
a. Adjustable [L] Long time time-delay and ampere setting.
b. Adjustable [S] Short time-delay and pick-up.
c. Adjustable [I] Instantaneous trip.
d. Adjustable [G] Ground fault pick-up and delay where indicated or required be NEC.
e. Where Indicated special zone control interlocking for main breaker and future main and tie breaker of double-ended substation switchboard
f. Short circuit, overload and ground fault trip indicators.
h. Trip device of circuit breakers shall be of same type for tripping coordination.

E. Feeder Circuit Breaker Assemblies 150 Amp and below:
1. Feeder Circuit breakers 150 Amp and below shall be thermal Magnetic Circuit breaker: Inverse time current element for low level overloads, and instantaneous magnetic trip element for short circuits, unless otherwise indicated or required to meet Section 2.4 C above. Minimum features below:
a. UL listed for 80 percent load application unless otherwise indicated on plans.
b. Circuit Breaker shall allow the UL listed field installation internal accessories (Auxiliary Switch, Shunt Trip, Undervoltage release, Bell Alarm Switch) without removal of cover to install. Circuit Breaker shall include Accessories as indicated on plans.
c. Circuit breaker handle accessories shall provide provisions for locking handle in the ‘ON’ or ‘OFF’ position
2. Where specifically indicated or required by NEC
a. Adjustable [L] Long time time-delay and ampere setting with Long time pickup (ampere setting) determined by interchangeable rating plug.
b. Adjustable [S] Short time-delay and pick-up.
c. Adjustable [I] Instantaneous trip.
d. Adjustable [G] Ground fault pick-up and delay where indicated or required be

NEC.

e. Where Indicated special zone control interlocking for main breaker and future main and tie breaker of double-ended substation switchboard
f. Short circuit, overload and ground fault trip indicators.
h. Trip device of circuit breakers shall be of same type for tripping coordination.

F. Fused Switch Assemblies:
1. FS W-S-865; quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle. Provide interlock to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse Clips: FS W-F-870. Designed to reject all except Class R fuses, type as specified.
2. Switch handles shall be provided with provisions for locking handle in the 'ON' or 'OFF' position.
3. Fusible Switch Assemblies, Larger than 800 Amperes: Bolted pressure contact switches. Fuse
4. Clips: FS W-F-870. Designed to accommodate Class L fuses.
5. Fuse Manufacturers: Bussmann, Shawmut, Brush, or approved equal.
6. Fuse Sizes: as indicated on the drawings. Provide an appropriate sized spare fuse cabinet (with nameplate and directory) with one spare set of fuses (minimum of three) for each current rating and type used on the entire project. All fuses shall be of the same manufacturer.

2.4 INSTRUMENTATION (when indicated on plans)

A. Three five ampere current transformers per breaker, including main terminated in a shorting block.

B. Three 120V potential transformers for main incoming voltage.

C. Meter .Provide a UL listed and digital multifunction power monitor. The monitor case shall be fully enclosed and shielded. The monitor shall accept a voltage monitoring range of up to 600 volts, phase to phase. The Monitor shall provide true RMS measurements of voltage, phase to neutral and phase to phase; current, per phase and neutral; real power, reactive power, apparent power, power factor and frequency. The Monitor shall monitor max/min average demand values for all current and power readings. The demand interval shall be user programmable. The Monitor shall have an accuracy of +/- 0.1% or better for volts and amps, and 0.2% for power functions, and shall meet IEC687 (0.2%).The monitor shall include a three line, integrated, light-emitting diode (LED) display. The display shall provide user access to all phase voltages (phase to neutral and phase to phase), currents (phase and neutral) , watts, VARs, VA, power factor, frequency and kwh. The monitor shall be microprocessor based and shall be fully user programmable. The monitor shall be provided with an RS485 digital communications port. The Monitor shall communicate using a MODBUS RTU protocol and shall have a communication baud rate of at least 57k.. The monitor shall be provided with one KYZ pulse outputs

2.5 OPTIONAL FEATURES

A. When indicated on drawings, provide single phasing protection with UL listed phase monitor, relays, shunt trip coils and all necessary accessories and wiring to trip designated circuit breakers (with motor loads) when voltage of any phase drops below 88 percent of rated voltage. Taylor “Phase Guard” Model PND with a two second delay.

2.6 LUGS AND HARDWARE

A. Cable connectors shall be mechanical type lugs, suitable for copper or aluminum cables. All hardware used on conductors shall have high tensile strength and a suitable protective finish. All connections shall be made with Belville washers.

2.7 PROVISIONS FOR HANDLING

A. Provide adequate lifting means.

B. Switchboard shall be capable of being rolled or moved into installation position and bolted directly to the floor without use of floor sills.

2.8 WIRING

A. Provide all necessary control and instrumentation wiring.

B. Provide fuses, fuse blocks, control transformers, terminal blocks with suitable numbering strips, relays, auxiliary contact switches on circuit breakers as required.

C. Locate terminal blocks for remote load monitoring transducers in CT compartment for future extension by Owner.

D. All low voltage and control wiring shall be physically isolated from live busses so that safe access can be obtained without de-energizing the switchboard.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install switchboard in locations shown on Drawings, in accordance with manufacturer’s written instructions and NEMA PB 2.1.

B. Tighten accessible bus connections and mechanical fasteners after placing switchboard.

C. Provide 2” high concrete leveling pad under switchboard. Dimension 6” larger than footprint of equipment. Anchor to pad with ½” anchor bolts.

3.2 FIELD QUALITY CONTROL

A. Testing: Refer to Section 260501 – Field Test and Operational Check.

3.3 IDENTIFICATION

A. Provide engraved lamacoid nameplate for the switchboard and each component.

B. Provide warning signs.

3.4 ADJUSTING AND CLEANING

A. Set field-adjustable switches and circuit breaker trip ranges.

B. Adjust all operating mechanisms for free mechanical movement.

C. On completion of installation, inspect interior and exterior of switchboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION

SECTION 26 24 16

PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including agreement between the owner and CM/GC and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes load centers and panelboards, overcurrent protective devices, and associated auxiliary equipment rated 600 V and less for the following types:
   1. Lighting and appliance branch-circuit panelboards.
   2. Distribution panelboards.

B. Related sections:
   1. Section 2605 1 - Field Test and Operational Check.
   2. Section 260526 - Grounding.

1.3 SUBMITTALS

A. Product Data: For each type of panelboard, overcurrent protective device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.
   1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:
      a. Enclosure types and details for types other than NEMA 250, Type 1.
      b. Bus configuration, current, and voltage ratings.
      c. Short-circuit current rating of panelboards and overcurrent protective devices.
      d. UL listing for series rating of installed devices.
      e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

C. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

D. Maintenance Data: For panelboards and components, include the following:
   1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
   2. Time-current curves, including selectable ranges for each type of overcurrent

protective device.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the NEC, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NEMA PB 1.

C. Comply with the NEC.

1.5 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:
1. Panelboards, Overcurrent Protective Devices and Accessories:
   a. Eaton Corp.; Cutler-Hammer Products.
   b. General Electric Co.; Electrical Distribution & Control Div.
   c. Siemens
   d. Square D Co.; Schneider Electric Brands
   e. Or approved equal.

2.2 FABRICATION AND FEATURES

A. Enclosures: Flush or surface mounted cabinets (as indicated on drawings). Construct cabinets with code gauge galvanized steel. Provide minimum 20” wide cabinets and extra wiring space where incoming feed-through or parallel lines are shown.
NEMA PB 1, Type 1, to meet environmental conditions at installed location.
1. Outdoor Locations: NEMA 250, Type 3R.
2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
4. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

B. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.

C. Doors: Provide door-in-door construction, made of cold-rolled steel. Inner door shall provide access to breaker handles and outer door shall provide access to wiring space as well. Inner door shall be completely flush with no visible bolts, screw-heads or hinges and with flush catch and lock. Outer door shall have concealed hinges, flush catch and lock to match inner door, located in line with inner door catch. (Tee bar handles are not acceptable).

D. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.

E. Directory Card: With transparent protective cover, mounted inside metal frame, inside panelboard door.

F. Bus: Hard-drawn copper, 98 percent conductivity. Attach circuit breakers to bus so that circuits 1, 3, and 5; 2, 4, and 6, or any three similarly numbered circuits form one three-phase, four-wire circuit.

G. Main and Neutral Lugs: Compression or mechanical type suitable for use with conductor material.

H. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.

I. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.

J. Isolated Equipment Ground Bus: Where indicated on drawings - Adequate for branch-circuit equipment ground conductors; insulated from box.

K. Extra-Capacity Neutral Bus: Where indicated on drawings, neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads. Where indicated on plans, On 120/208Y Panels fed by K factor Type Transformer.

L. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor. Where indicated on plans.

M. Gutter Barrier: Arrange to isolate individual panel sections.

N. Feed-through Lugs: Compression or mechanical type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device. For two-section panels.

O. Panels located adjacent to each other shall have identically sized enclosures and trims.

2.3 PANELBOARD SHORT-CIRCUIT RATING

A. UL label indicating series-connected rating with integral or remote upstream devices. Include size and type of upstream device allowable, branch devices allowable, and UL

series-connected short-circuit rating. If not series rated: Fully rated to interrupt symmetrical short-circuit current available at terminals or the rating indicated on the plans, whichever is higher.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Branch Overcurrent Protective Devices:
   1. 120/208Y volt branch circuit panelboards: Quick-make, quick-break, molded case plug-in type designed for 120/208Y volt, three-phase, four-wire service with minimum 10,000 amperes rms short circuit rating.
   2. 277/480Y volt branch circuit panelboards: Molded case bolt-on type designed for 277/480Y volt, three-phase, four-wire service with minimum 14,000 amperes rms short circuit rating.
   3. Provide multi-pole units with common trip elements.
   4. Breaker shall have center-tripped position in addition to the ON and OFF positions.
   5. Provide lockouts for all circuits that should not be inadvertently tripped (as indicated on the drawings).

2.5 DISTRIBUTION PANELBOARDS

A. Dead-front, dead-rear, Nema 1 or 3R enclosure as indicated, designed for use on a three-phase, four-wire, 120/208Y or 277/480Y volt system. See drawings for additional details.

B. Construction: Code gauge galvanized steel fully flanged for strength and rigidity. Door and trim shall be cold-rolled steel, code gauge. Provide concealed butt hinges and 3-point catch and lock. Provide separately hinged or bolted vertical access doors over lug and wiring spaces.

C. Bus Bars: Panel shall be fully bussed. Shall be used throughout and shall be hard-rolled, electrolytic copper of 98% conductivity designed for a maximum 1000 amperes per square inch. Bars shall be factory pre-drilled to accept future field installation of 2 or 3 pole circuit breakers in any combination. Brace all bus bars for required short circuit rating of the panel, but in no case less than 35,000 amperes rms, Refer to Short Circuit information above for additional requirements.

D. Main Overcurrent Protective Devices: Circuit breaker unless otherwise noted.

E. Provide handle locking devices for all circuit breakers.

F. Provide engraved nameplates with minimum ¼” high letters secured to panel front and for each circuit protective device in panel.

2.6 OVERCURRENT PROTECTIVE DEVICES

A. Main Breaker (or Feeder) Assemblies rated for 1200 Amps:

1. Main (or feeder) breakers rated for 1200 Amp may be Molded Case with temperature insensitive, solid state trips, current sensors and solid state logic circuit integral with the frame. All circuit breakers shall be of same design for over-current and ground fault trip coordination. The Circuit breakers shall have the following features:
   a. UL listed for 80 percent load application unless otherwise indicated on plans as 100% rated.
   b. Adjustable [L] Long time time-delay and ampere setting.
   c. Adjustable [S] Short time-delay and pick-up.
   d. Adjustable [I] Instantaneous trip.
   e. For 277/480Y systems rated 1000 Amp or higher - Adjustable [G] Ground fault pick-up and delay is required.
   f. Adjustable [G] Ground fault pick-up and delay where indicated or required be NEC.
   g. Adjustable [R] Reduced Entergy Let-Through (RELT) Instantaneous trip. This feature shall be provided on breakers to provide a temporary setting for the instantaneous trip setting of the breaker. Setting shall be adjustable down to 1.5X of the rating plug and shall be enabled through a switch mounted on front of the switchboard. The switch shall be combined with an indicating light that positively indicates that the RELT is enabled or disabled.
   h. Where Indicated special zone control interlocking for main breaker and future main and tie breaker of double-ended substation switchboard.
   i. Short circuit, overload and ground fault trip indicators.

B. Feeder Circuit Breaker Assemblies 400 Amps or larger:
   1. Feeder Circuit breakers 400 Amps or larger shall be digital solid state true RMS sensing Molded Case Circuit Breakers with temperature insensitive, solid state trips, current sensors and solid state logic circuit integral with the frame. All circuit breakers shall be of same design for over-current and ground fault trip coordination. The Circuit Breakers shall have the following minimum features:
      a. UL listed for 80 percent load application unless otherwise indicated on plans.
      b. Long time pickup (ampere setting) determined by interchangeable rating plug .
      c. Adjustable instantaneous with short time tracking function.
      d. Circuit Breaker shall allow the UL listed field installation internal accessories (Auxiliary Switch, Shunt Trip, Undervoltage release, Bell Alarm Switch) without removal of cover to install. Circuit Breaker shall include Accessories as indicated on plans.
      e. Circuit breaker handle accessories shall provide provisions for locking handle in the ‘ON’ or ‘OFF’ position
   2. Where specifically indicated or required by NEC
      a. Adjustable [L] Long time time-delay and ampere setting.
      b. Adjustable [S] Short time-delay and pick-up.
      c. Adjustable [I] Instantaneous trip.
      d. Adjustable [G] Ground fault pick-up and delay where indicated or required be NEC.
      e. Where Indicated special zone control interlocking for main breaker and future main and tie breaker of double-ended substation switchboard
      f. Short circuit, overload and ground fault trip indicators.

h. Trip device of circuit breakers shall be of same type for tripping coordination.

C. Feeder Circuit Breaker Assemblies 150 Amp and below:
1. Feeder Circuit breakers 150 Amp and below shall be thermal Magnetic Circuit breaker: Inverse time current element for low level overloads, and instantaneous magnetic trip element for short circuits, unless otherwise indicated or required to meet Section 2.4 C above. Minimum features below:
a. UL listed for 80 percent load application unless otherwise indicated on plans.
b. Circuit Breaker shall allow the UL listed field installation internal accessories (Auxiliary Switch, Shunt Trip, Undervoltage release, Bell Alarm Switch) without removal of cover to install. Circuit Breaker shall include Accessories as indicated on plans.
c. Circuit breaker handle accessories shall provide provisions for locking handle in the 'ON' or 'OFF' position
2. Where specifically indicated or required by NEC
a. Adjustable [L] Long time time-delay and ampere setting with Long time pickup (ampere setting) determined by interchangeable rating plug.
b. Adjustable [S] Short time-delay and pick-up.
c. Adjustable [I] Instantaneous trip.
d. Adjustable [G] Ground fault pick-up and delay where indicated or required be NEC.
e. Where Indicated special zone control interlocking for main breaker and future main and tie breaker of double-ended substation switchboard
f. Short circuit, overload and ground fault trip indicators.
g. Trip device of circuit breakers shall be of same type for tripping coordination.

D. General Breaker Requirements:
1. Minimum interrupting capacity shall match the minimum required interrupt rating of the panel.
2. Standard frame sizes, trip ratings, and number of poles.
3. Lugs: Mechanical or compression style, suitable for number, size, trip ratings, and material of conductors.
4. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
5. GFCI Circuit Breakers: Single- and two-pole configurations with 5-mA trip sensitivity.
6. Shunt Trip: 120-V trip coil energized from separate circuit.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Clearances: Minimum code required clearances around panelboards must be maintained.

C. Mounting Heights: Top of trim 78 inches above finished floor, unless otherwise indicated.

D. Mounting: Plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.

E. Mounting Hardware: Provide all necessary blocking, channels and other hardware for securing panelboards to wall, column or other parts of building structure.

F. Circuit Directory: Create a directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

G. Install filler plates in unused spaces.

H. Wiring in Panelboard Gutters: Arrange conductors into groups and bundle and wrap with wire ties after completing load balancing.

3.2 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components.

B. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws. Label shall include panel designation, voltage and phase in minimum ¼” high letters.

3.3 CONNECTIONS

A. Install equipment grounding connections for panelboards with ground continuity to main electrical ground bus.

B. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.

3.4 FIELD QUALITY CONTROL

A. Testing: Refer to Section 260501 – Field Test and Operational Check.

B. After installing panelboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements
   1. Procedures: Perform each visual and mechanical inspection and electrical test indicated in NETA ATS, Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Balancing Loads: After Substantial Completion, measure load balancing and make

circuit changes as follows:

1. Measure as directed during period of normal system loading.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.5 ADJUSTING

A. Set field-adjustable switches and circuit breaker trip ranges.

B. Adjust all operating mechanisms for free mechanical movement.

3.6 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION

SECTION 26 27 26

WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including agreement between the owner and CM/GC and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes receptacles, switches, and finish plates.

1.3 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter.

B. TVSS: Transient voltage surge suppressor.

1.4 SUBMITTALS

A. Submit shop drawings and product data.

1.5 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:

B. Wiring Devices:
1. Bryant; Hubbell, Inc.
2. GE Company; GE Wiring Devices.
3. Hubbell Wiring Device – Kellems
4. Leviton Manufacturing Co., Inc.
5. Pass & Seymour/Legrand; Wiring Devices Div.
6. Cooper Wiring Devices

7. Or approved equal.

C. Wiring Devices for Hazardous (Classified) Locations:
1. Crouse-Hinds Electrical Co.; Distribution Equipment Div. or approved equal.

D. Multi-outlet Assemblies:
1. Wiremold.
2. Hubbell, Inc.; Wiring Devices Div.
3. Or approved equal.

2.2 RECEPTACLES

A. General Requirements for All Devices:

B. Each device shall have an amperage rating not less than that of the branch circuit(s) overcurrent protection device. Gray color, unless noted otherwise.

C. For all Emergency devices when backed up by an emergency generator, the color of the device and cover plate shall be Red.

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

E. All devices shall be Commercial Specification Grade (Construction specification grade is prohibited), unless noted otherwise.

F. All Convenience Receptacles, shall be Heavy-Duty 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596. Subject to compliance with requirements, provide Hubbell Wiring Device-Kellems; 5362 Series or similar

G. All devices in Hospitals and all patient care areas within non-hospital buildings shall be Hospital Grade.

H. Hospital-Grade, Heavy Duty, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, and FS W-C-596. Subject to compliance with requirements, provide Hubbell Wiring Device-Kellems; 8300 Series or similar

I. Straight-Blade: All devices shall be Tamper Resistant where required by the National Electric Code and/or local amendments.

J. Tamper Resistant—Convenience Receptacles: 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, and FS W-C-596. Subject to compliance with requirements, provide Hubbell Wiring Device-Kellems; HBL5362xxTR Series or similar.

K. Tamper Resistant—Convenience Receptacles: 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, and FS W-C-596. Subject

to compliance with requirements, provide Hubbell Wiring Device-Kellems; HBL5362xxTR Series or similar.

L. GFCI Receptacles: Duplex convenience receptacle with integral ground fault current interrupter. Provide one device for each location, daisy-chaining devices to achieve GFCI protection is not approved for this project.

M. Duplex GFCI Convenience Receptacles, 125 V, 20 A.

N. Straight Blade, non-feed through type.

O. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.

P. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

Q. Subject to compliance with requirements, provide Hubbell Wiring Device-Kellems; GFRST20xx Series or similar.

R. Isolated-Ground Receptacles: Equipment grounding contacts connected only to the green grounding screw terminal of the device with inherent electrical isolation from mounting strap, orange plastic face.

S. General Description: Straight Blade, 125 V, 20 A, Configuration 5-20R. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 1449, and FS W-C-596, with integral TVSS in line to ground, line to neutral, and neutral to ground.

T. TVSS Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 V and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.

U. Active TVSS Indication: Visual and audible, with light visible in face of device to indicate device is "active" or "no longer in service.

V. Subject to compliance with requirements, provide Hubbell Wiring Device-Kellems; HBL5362SA Series or similar.

W. Devices: Listed and labeled as isolated-ground receptacles.

X. Isolation Method: Integral to receptacle construction and not dependent on removable parts.

Y. TVSS Receptacles: Duplex type, NEMA WD 6, with integral TVSS in line to ground, line to neutral, and neutral to ground, blue plastic face.

Z. General Description: Straight Blade, 125 V, 20 A, Configuration 5-20R. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 1449, and FS W-C-596, with integral TVSS in line to ground, line to neutral, and neutral to ground.

AA. TVSS Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of

400 V and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.

BB. Active TVSS Indication: Visual and audible, with light visible in face of device to indicate device is "active" or "no longer in service."

CC. Subject to compliance with requirements, provide Hubbell Wiring Device-Kellems; HBL5362SA Series or similar.

DD. Mulit-Outlet assemblies: Metal with Gray color finish.

EE. Two-piece surface (painted steel, brushed aluminum) raceway, with factory-wired multi-outlet harness.

FF. Components shall be products from single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

GG. Receptacles: 20 A, 125-V, NEMA WD 6 Configuration 5-20R receptacles complying with NEMA WD 1, UL 498, and FS W-C-596.

HH. Receptacle Spacing: [6 inches (150 mm)] [9 inches (230 mm)] [12 inches (300 mm)] [18 inches (460 mm)].

II. Wiring: No. 12 AWG solid, Type THHN copper, [single circuit] [two circuit, connecting alternating receptacles].

2.3 SWITCHES

A. Snap Switches: General-duty, quiet type, rated 20 amperes, 120/277 volts AC. Handle: gray plastic. Pilot light type (where indicated): lighted handle.

B. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on/off switches and audible and electromagnetic noise filters.

C. Control: Continuously adjustable slide. Single-pole or three-way switch to suit connections.

D. Incandescent Lamp Dimmers: Modular, 120 V, 60 Hz with continuously adjustable slide; single pole with soft tap or other quiet switch; electromagnetic filter to eliminate noise, RF, and TV interference; and 5-inch wire connecting leads.

E. Fluorescent Lamp Dimmers: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming to a maximum of 1 percent of full brightness.

2.4 WALL PLATES

A. Single and combination types match corresponding wiring devices.

1. Cover plate: Smooth stainless steel unless noted otherwise.
2. Cover plate for surface mounted devices: Galvanized steel.
3. Weatherproof cover plate: While in use, gasketed, cast metal, hinged device covers.
4. Plate-Securing Screws: Metal with head color to match plate finish.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install devices and assemblies plumb and secure.

B. Install wall plates when painting is complete.

C. Install wall dimmers to achieve indicated rating after derating for ganging as instructed by manufacturer.

D. Do not share neutral conductor on load side of dimmers.

E. Arrangement of Devices: Unless otherwise indicated, mount flush, vertically, with height as indicated or six inches above counters.

F. Group adjacent switches under single, multigang wall plates.

G. Protect devices and assemblies during painting.

H. Install wall switches with off position down.

I. Install cover plates on switch, receptacle, and blank outlets.

3.2 IDENTIFICATION

A. Switches and receptacles: Identify panelboard and circuit number from which served. Use machine-printed, pressure-sensitive, abrasion-resistant label tape on the outside of the face plate for receptacles and on the inside of the face plate for switches; utilize durable wire markers or tags within all outlet boxes. Labels shall be Brother ½" TZ tape, black ink on clear, extra-strength adhesive tape, with size 18 text or engineer approved equal. Use matching label printer.

3.3 CONNECTIONS

A. Connect wiring device grounding terminal to outlet box with bonding jumper.

B. Connect wiring device grounding terminal to branch-circuit equipment grounding conductor.

C. Isolated-Ground Receptacles: Connect to isolated-ground conductor routed to designated isolated equipment ground terminal of electrical system.

D. Tighten electrical connectors and terminals according to manufacturer’s published torque-tightening values.

3.4 FIELD QUALITY CONTROL

A. Test wiring devices for proper polarity and ground continuity. Check each device to verify operation.

B. Test GFCI operation according to manufacturer's written instructions.

C. Replace damaged or defective components.

3.5 CLEANING

A. Internally clean devices, device outlet boxes, and enclosures. Replace stained or improperly painted wall plates or devices.

END OF SECTION

SECTION 26 28 13

FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including agreement between the owner and CM/GC and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes cartridge fuses, rated 600 V and less, for use in switches, panelboards, switchboards, starters, and motor control centers; and spare fuse cabinets.

1.3 SUBMITTALS

A. Product Data: Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings for each fuse type indicated.

1.4 QUALITY ASSURANCE

A. Source Limitations: Provide fuses from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the NEC, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NEMA FU 1.

D. Comply with the NEC.

1.5 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.6 COORDINATION

A. Coordinate fuse ratings with HVAC and refrigeration equipment nameplate limitations of maximum fuse size.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged in original cartons or containers and identified with labels describing contents.
   1. Fuses: Furnish one set of three of each type and size.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:
   1. Cooper Industries, Inc.; Bussmann Div.
   2. Gould Shawmut.
   3. Tracor, Inc.; Littelfuse, Inc. Subsidiary.
   4. Or approved equal.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.

2.3 SPARE FUSE CABINET

A. Cabinet: Wall-mounted, 0.05-inch thick steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
   1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
   2. Finish: Gray, baked enamel.
   3. Identification: "SPARE FUSES" in 1-1/2-inch- high letters on exterior of door.
   4. Fuse Pullers: For each size fuse.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

B. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be

applied to fuse ratings.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install spare fuse cabinet.

3.3 IDENTIFICATION

A. Install labels indicating fuse replacement information on inside door of each fused switch.

END OF SECTION

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SECTION 26 28 15

DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including agreement between the owner and CM/GC and Division 1 Specification sections, apply to work of this section.

1.2 WORK INCLUDED

A. Provide and install motor disconnects.

B. Provide and install circuit disconnects.

1.3 REFERENCES

A. Underwriters' Laboratory, Inc. - Annual Product Directories.

B. NEMA - Classification of Standard Types of Nonventilated Enclosures for Electric Controllers.

1.4 REGULATORY REQUIREMENTS

A. Conform to National Electrical Code and to applicable inspection authority.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Cutler-Hammer/Westinghouse, General Electric, Siemens, Square D, or approved equal.

2.2 COMPONENTS

A. Motor and circuit disconnects shall have an Underwriters' Laboratory label.

B. Single Phase 120 Volt Disconnect Switches: Single pole toggle switch with thermal overload motor protection where indicated. A Horse Power rated switch may be used where fractional horse power motors have internal overload protection.

C. Single or Three Phase Motor Disconnect Switches: two or three pole heavy duty or fusible where other loads are on same circuit, 250 or 600 volt as required in NEMA Type 1, 3R, or 4 enclosures designed to reject all except Class 'R' fuses.

2.3 ACCEPTABLE MANUFACTURERS - FUSES

A. Cooper Bussmann, Edison, Littelfuse, Ferraz Shawmut, or approved equal.

2.4 FUSES

A. As indicated on the drawings. All shall be of the same manufacturer. Provide one spare set of fuses (minimum of three) for each current rating and type used. See Section 262813.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install motor and circuit disconnect as indicated on Drawings and as required by Code. Where fuses are indicated, provide fuses correlated with full load current of motors provided.

END OF SECTION

SECTION 26 51 00

INTERIOR / EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including agreement between the owner and CM/GC and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes interior lighting fixtures, lighting fixtures mounted on exterior building surfaces and recessed in canopies, Light Emitting Diodes, drivers, and accessories.

B. Related Sections include the following:
1. Section 260923 Lighting Control Devices.

1.3 SUBMITTALS

A. Product Data: For each type of lighting fixture indicated, arranged in order of fixture designation. Include data on features and accessories.

B. Maintenance data for lighting fixtures.

1.4 QUALITY ASSURANCE

A. Fixtures, and Accessories: Listed and labeled as defined in the NEC, Article 100, by a nationally recognized testing agency acceptable to authorities having jurisdiction.

B. Comply with the NEC.

C. FM Compliance: Fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM.

D. NFPA 101 Compliance: Comply with visibility and luminance requirements for exit signs.

1.5 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other

construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, partition assemblies, and other construction.

1.6 WARRANTY

A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components that fail in materials or workmanship within specified warranty period.
   1. Warranty Period for Lighting fixtures: Five years from date of Substantial Completion.

B. Special Warranty for Ballasts: Manufacturer's standard form in which ballast manufacturer agrees to repair or replace ballasts that fail in materials or workmanship within specified warranty period.
   1. Warranty Period for Electronic Ballasts: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: As indicated on the drawings.

2.2 FIXTURES AND FIXTURE COMPONENTS, GENERAL

A. Metal Parts: Free from burrs, sharp corners, and edges.

B. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally and secured in operating position.

D. Lenses, Diffusers, Covers, and Globes: 100 percent virgin acrylic plastic or annealed crystal glass, unless otherwise indicated.
   1. Plastic: High resistance to yellowing and other changes due to aging, exposure to heat, and ultraviolet radiation.
   2. Lens Thickness: 0.125 inch minimum unless greater thickness is indicated.

2.3 Lighting Emitting Diode light fixtures

A. General Requirements:

1. See lighting fixture schedule on drawings.

FIXTURE SUPPORT COMPONENTS

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fitting and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy arranged to mount a single fixture. Finish same as fixture.

D. Rod Hangers: 3/16-inch- minimum diameter, cadmium-plated, threaded steel rod.

E. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

F. Aircraft Cable Support: Use cable, anchorages, and intermediate supports recommended by fixture manufacturer.

G. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm)

2.4 FINISHES

A. Fixtures: Manufacturer's standard, unless otherwise indicated.
1. Paint Finish: Applied over corrosion-resistant treatment or primer, free of defects.
2. Metallic Finish: Corrosion resistant.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Fixtures: Set level, plumb, and square with ceiling and walls, and secure according to manufacturer's written instructions and approved submittal materials. Install lamps in each fixture.

B. Furnish and install a protective barrier around fixtures that are not insulation-contact-rated (non-IC-rated) in locations where insulation is installed. The protective barrier shall be installed to yield a 4” airgap from the fixture on all sides and top.

C. Support for Fixtures in or on Grid-Type Suspended Ceilings: Attach supports to building structure.
1. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches from fixture corners.
2. Support Clips: Fasten to fixtures and to ceiling grid members at or near each fixture corner.

3. Fixtures of Sizes Less Than Ceiling Grid: Arrange as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.

D. Suspended Fixture Support: As follows:
1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
3. Continuous Rows: Suspend from cable installed according to fixture manufacturer's written instructions and details on Drawings.

3.2 CONNECTIONS

A. Ground equipment.
1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.

3.3 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Tests: As follows:
1. Verify normal operation of each fixture after installation.
2. Emergency Lighting: Interrupt electrical supply to demonstrate proper operation.

C. Malfunctioning Fixtures and Components: Replace or repair, then retest. Repeat procedure until units operate properly.

D. Ballasts: Replace all noisy ballasts. Ballasts that can be heard shall be considered noisy. Repeat the procedure until a ballast is installed that is not noisy.

3.4 CLEANING AND ADJUSTING

A. Clean fixtures internally and externally after installation. Use methods and materials recommended by manufacturer.

B. Adjust aimable fixtures to provide required light intensities.

END OF SECTION

SECTION 26 52 00

EMERGENCY LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes emergency lighting units and exit signs.

1.2 REFERENCES

A. National Electrical Manufacturers Association:

B. NEMA WD 6 - Wiring Devices-Dimensional Requirements.

1.3 SYSTEM DESCRIPTION

A. Emergency lighting to comply with requirements.

1.4 PRIOR APPROVAL

A. General:
   1. Catalog and manufacturer's numbers are for the purpose of establishing standards of quality and types of materials to be used. Products of other manufacturers may be used if equal in quality and design in the opinion of the Engineer and are specifically approved by the Engineer, in writing, 10 days prior to close of bidding.
   2. Any conflict arising from the use of substituted equipment shall be the responsibility of the supplier of that equipment. The contractor and his supplier shall bear all costs required to make equipment comply with the intent of the plans and specifications.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit dimensions, ratings, and performance data.

C. Samples: Submit two color chips 3 x 3 inch in size illustrating unit finish color.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years' experience.

1.7 MAINTENANCE MATERIALS

A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.

B. Furnish one replacement lamp for each lamp installed.

PART 2 - PRODUCTS

2.1 EMERGENCY LIGHTING UNITS

A. As shown on the Fixture Schedule.

B. All alternate emergency light fixtures shall be submitted a minimum of 7 days prior to bid for approval.

2.2 EXIT SIGNS

A. As shown on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install suspended exit signs using pendants supported from swivel hangers. Install pendant length required to suspend sign at indicated height.

B. Install surface-mounted exit signs plumb and adjust to align with building lines and with each other. Secure to prevent movement.

C. Install accessories furnished with each emergency lighting unit.

D. Connect emergency lighting units and exit signs to branch circuit out as indicated on Drawings.

E. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within unit.

F. Ground and bond emergency lighting units and exit signs in accordance with Section 26 05 26.

3.2 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements, 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Operate each unit after installation and connection. Inspect for proper connection and operation.

3.3 ADJUSTING

A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.

B. Position exit sign directional arrows as indicated on Drawings.

3.4 PROTECTION OF FINISHED WORK

A. Section 01 70 00 - Execution and Closeout Requirements: Protecting finished work.

B. Replace emergency lighting units and exit signs having failed lamps at Substantial Completion.

END OF SECTION

SECTION 27 05 33

CONDUITS AND BACKBOXES FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes conduit and tubing, surface raceways, wire ways, outlet boxes, pull and junction boxes, and hand holes.

1.2 REFERENCES

A. American National Standards Institute:
   1. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated
   2. ANSI C80.3 - Specification for Electrical Metallic Tubing, Zinc Coated

B. National Electrical Manufacturers Association:
   1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)
   2. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies
   3. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports
   4. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports

1.3 SYSTEM DESCRIPTION

A. Raceway and boxes located as indicated on Drawings, and at other locations required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements. Raceway and boxes are shown in approximate locations unless dimensioned. Provide raceway to complete wiring system.

B. Concealed Dry Locations: Provide electrical metallic tubing and nonmetallic conduit. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas.

C. Exposed Dry Locations: Provide electrical metallic tubing and nonmetallic conduit. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas.

1.4 DESIGN REQUIREMENTS

A. Minimum Raceway Size: 1 inch unless otherwise specified.

1.5 PRIOR APPROVAL

A. General:
   1. Catalog and manufacturer's numbers are for the purpose of establishing standards of quality and types of materials to be used. Products of other manufacturers may be used if equal in quality and design in the opinion of the Engineer and are specifically approved by the Engineer, in writing, 10 days prior to close of bidding.
   2. Any conflict arising from the use of substituted equipment shall be the responsibility of the supplier of that equipment. The contractor and his supplier shall bear all costs required to make equipment comply with the intent of the plans and specifications.

1.6 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit for the following:
   1. Electrical metallic tubing
   2. Surface raceway
   3. Floor boxes

C. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.7 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents:
   1. Record actual locations and mounting heights of outlet, pull, and junction boxes.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

1.9 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Coordinate installation of outlet boxes for equipment connected under Section 26 05 33.

C. Coordinate mounting heights, orientation and locations of outlets mounted above counters, benches, and backsplashes.

PART 2 - PRODUCTS

2.1 ELECTRICAL METALLIC TUBING (EMT)

A. Product Description: ANSI C80.3; galvanized tubing.

B. Fittings and Conduit Bodies: NEMA FB 1; steel compression type.

2.2 SURFACE METAL RACEWAY

A. Manufacturers:
1. Carlon Electrical Products
2. Hubbell Wiring Devices
3. Thomas & Betts Corp.
4. Walker Systems Inc.
5. The Wiremold Co.

B. Product Description: Sheet metal channel with fitted cover, suitable for use as surface metal raceway.

2.3 SURFACE NONMETAL RACEWAY

A. Manufacturers:
1. Carlon Electrical Products
2. Hubbell Wiring Devices
3. Thomas & Betts Corp.
4. Walker Systems Inc.
5. The Wiremold Co.

B. Product Description: Fiberglass channel with fitted cover, suitable for use as surface raceway.

C. Finish: Ivory

D. Fittings, Boxes, and Extension Rings: Furnish manufacturer’s standard accessories, finish to match raceway.

2.4 OUTLET BOXES

A. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.

1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; furnish 1/2 inch male fixture studs where required.
2. Concrete Ceiling Boxes: Concrete type.

B. Wall Plates for Finished Areas: As specified in Section 26 27 26.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Verify outlet locations and routing and termination locations of raceway prior to rough-in.

3.2 EXISTING WORK

A. Remove exposed abandoned raceway. Cut raceway flush with walls and floors, and patch surfaces.

B. Remove concealed abandoned raceway to its source.

C. Disconnect abandoned outlets and remove devices. Remove abandoned outlets when raceway is abandoned and removed. Install blank cover for abandoned outlets not removed.

D. Maintain access to existing boxes and other installations remaining active and requiring access. Modify installation or provide access panel.

E. Extend existing raceway and box installations using materials and methods as specified.

F. Clean and repair existing raceway and boxes to remain or to be reinstalled.

3.3 INSTALLATION

A. Install Work in accordance with standards.

B. Identify raceway and boxes in accordance with Section 26 05 53.

C. Arrange raceway and boxes to maintain headroom and present neat appearance.

3.4 INSTALLATION - RACEWAY

A. Raceway routing is shown in approximate locations unless dimensioned. Route to

complete wiring system.

B. Arrange raceway supports to prevent misalignment during wiring installation.

C. Support raceway using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.

D. Do not support raceway with wire or perforated pipe straps. Remove wire used for temporary supports

E. Do not attach raceway to ceiling support wires or other piping systems.

F. Construct wire way supports from steel channel specified in Section 26 05 29.

G. Route exposed raceway parallel and perpendicular to walls.

H. Route raceway installed above accessible ceilings parallel and perpendicular to walls.

I. Maintain clearance between raceway and piping for maintenance purposes.

J. Maintain 12-inch clearance between raceway and surfaces with temperatures exceeding 104 degrees F.

K. Cut conduit square using saw or pipe cutter; de-burr cut ends.

L. Bring conduit to shoulder of fittings; fasten securely.

M. Install no more than equivalent of three 90-degree bends between boxes. Install conduit bodies to make sharp changes in direction, as around beams.

3.5 INSTALLATION - BOXES

A. Contractor to install all rough-in boxes for data cabling.

3.6 INTERFACE WITH OTHER PRODUCTS

A. Install conduit to preserve fire resistance rating of partitions and other elements.

3.7 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.

B. Clean interior of boxes to remove dust, debris, and other material.

C. Clean exposed surfaces and restore finish.

END OF SECTION

SECTION 27 11 01

TELECOM RACEWAY SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including agreement between the owner and CM/GC and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes telecom raceway systems.

1.3 RELATED WORK

A. Section 26 05 33 – Raceways and Boxes.

B. Section 26 05 36 – Cable Trays.

1.4 SYSTEM DESCRIPTION

A. Conduit, cable trays and boxes to form an empty raceway system.

PART 2 - PRODUCTS

2.1 EQUIPMENT

A. Conduit: Refer to Section 26 05 33.

B. Cable trays: Refer to Section 26 05 36.

C. Outlet, pull or junction boxes: Refer to Section 26 05 33.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide pullboxes in telecom conduit runs spaced less than 100 feet apart, and on the backboard side of runs with more than two right angle bends.

B. Place telecom label on pull and junction boxes.

C. Provide pullwire in each telecom conduit run.

END OF SECTION

DIVISION 27 COMMUNICATIONS

SECTION 271343 - COMMUNICATION SERVICES CABLING

PART 1 - GENERAL

1.1 GENERAL

A. This document provides minimum standards and directions for a structured cable system to be installed.

B. All new cabling must conform to BICSI TDMM, ANSI/TIA/EIA, NEMA, and NFPA standards and integrate with the existing infrastructure.

1.2 STANDARDS

A. Building structured wiring systems shall meet the cabling conventions of CSI Networking & Telecommunications Department to include adherence to the most currently available Building Industry Consulting Service International (BICSI) Telecommunications Distribution Methods Manual (TDMM 10th Edition), ANSI/TIA/EIA Telecommunications Building Wiring Standards ISBN: 0-9112702-73-7, National Electrical Manufacturer's Association (NEMA) NEMA WC 26, and National Electrical Code 2008 NFPA 70 manuals

B. Bidders shall be fully acquainted with the above referenced standards and be fully qualified, as outlined in the Telecommunications contractor qualifications, to bid on and perform work. Bidders shall have demonstrated manufacturer authorization, qualifications and certifications to install and test a Category 6 (CAT 6) Solution. All station and riser cabling shall be tested and certified by a successful bidder to support 1000BaseTX/FX technology. Additionally, the successful bidder will be required to meet CSI conventions and standards. The successful bidder will be required to meet with and coordinate with a representative of CSI prior to work beginning, and weekly, during the installation process. Weekly meetings will include a site inspection to ensure compliance with the defined standards contained in this document. The successful electrical and telecommunications contractor(s) shall follow appropriate installation guidelines, as contained in the most currently available BICSI TDMM, ANSI/TIA/EIA, NEMA WC 26, and NFPA 70 manuals. Additionally, the contractor will work with CSI to ensure proper placement and routing of cable and support hardware. The specified Structured Cable Wiring Standards are to be used as a minimum requirement.

1.3 TELECOMMUNICATIONS CONTRACTOR QUALIFICATIONS

A. Only qualified and experienced Telecommunications contractors perform design, project management, and installation services in the construction of the CSI structured cabling infrastructure. Pursuant to this, CSI wants to ensure that successful contractors have the manufacturer authorizations, capabilities, qualifications, financial stability, and experience to complete Telecommunications installations using common industry practices (i.e. BICSI TDMM, ANSI/TIA/EIA, NEMA, NFPA, etc.) while meeting

all CSI guidelines.

B. A contractor, by responding to a bid, represents that their company possesses the manufacturer authorizations, qualifications, certifications, capabilities, test equipment, expertise, and personnel necessary to provide an efficient and successful installation of properly operating components, as specified.

C. The bidder must meet the requirement of having continuously performed Telecommunications installation work for a period of at least five (5) years. The Telecommunications contractor must be an approved Certified Installer for the system installed. The Telecommunications contractor is responsible for workmanship and installation practices in accordance with the a 25-year Warranty to the end user once the Telecommunications contractor fulfills all requirements. At least 30 percent of the copper installation and termination crew must be certified by BICSI.

D. Prior to submitting bid, bidder is required to carefully consider the amount and character of the work to be done, as well as the difficulties involved in its proper execution. Bidder should include in their bid all costs deemed necessary to cover contingencies essential to successfully installing the specified system. Any cost not specifically itemized in the proposal shall not be incurred unless specifically agreed upon by all parties and documented in writing. No claims for compensation will be considered or allowed for extra work resulting from lack of knowledge of any existing conditions on the part of the bidder.

E. As a requirement to bidding and performing awarded work, Telecommunications contractor shall have a currently trained, registered, and certified BICSI Technician on staff as a full-time employee. A copy of certifications and BICSI member number must be provided with bidding documents.

F. Telecommunication contractors must be skilled and proficient in both inside cable plant (copper and fiber optics) installation, as well as outside cable plant (copper and fiber optics) installation, termination, splicing, and testing. Telecommunications contractors must be certified by the manufacture of the structured cable system specified in this document. (See 1.8 Materials)

1.4 PRIOR APPROVAL

A. General:
   1. Catalog and manufacturer's numbers are for the purpose of establishing standards of quality and types of materials to be used. Products of other manufacturers may be used if equal in quality and design in the opinion of the Design Professional and are specifically approved by the Design Professional, in writing, 6 days prior to closing of bidding.
   2. Any conflict arising from the use of substituted equipment shall be the responsibility of the supplier of that equipment. The contractor and his supplier shall bear all costs required to make equipment comply with the intent of the plans and specifications.

1.5 PROGRESS MEETINGS

A. The successful bidder will be required to meet with and coordinate with a representative of CSI prior to work beginning, and weekly, during the installation process. Weekly meetings will include a site inspection to ensure compliance with established standards. The successful electrical and Telecommunications contractor(s) will follow appropriate installation guidelines, as contained in the most currently available BICSI TDMM, ANSI/TIA/EIA Wiring Standards, NEMA and NFPA 70 National Electrical Code manuals. Additionally, contractors will work with CSI to ensure proper placement, routing, labeling, and documentation of cable and support hardware.

1.6 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections:
   1. Prior approval
      a. Catalog and manufacturer's numbers are for the purpose of establishing standards of quality and types of materials to be used. Products of other manufacturers may be used if equal in quality and design in the opinion of the Design Professional and are specifically approved by the Design Professional, in writing, 10 days prior to close of bidding.
      b. Any conflict arising from the use of substituted equipment shall be the responsibility of the supplier of that equipment. The contractor and his supplier shall bear all costs required to make equipment comply with the intent of the plans and specifications.
   2. Product Data for each item of telecommunications equipment
   3. Shop Drawings:
      a. Catalog and manufacturer's numbers are for the purpose of establishing standards of quality and types of materials to be used. Products of other manufacturers may be used if equal in quality and design in the opinion of the Design Professional and are specifically approved by the Design Professional, in writing, 10 days prior to close of bidding.
      b. Any conflict arising from the use of substituted equipment shall be the responsibility of the supplier of that equipment. The contractor and his supplier shall bear all costs required to make equipment comply with the intent of the plans and specifications.
      c. Do not purchase equipment before completion of shop drawing review.
      d. Design Professional will not review shop drawings before the contractor has reviewed the shop drawings. The contractor shall stamp all drawings with a statement that he has reviewed all shop drawings and that they conform to the intent of the drawings and specifications.
   4. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.7 DOCUMENTATION

A. Prior to system acceptance, the successful bidder shall submit to the design consultant fully documented 8.5" x 11" scale drawings of the entire fiber optic and copper distribution system. Documentation shall be provided in both a hard copy binder and a soft copy on CD capable of being viewed and edited in MS Visio. This

will include building and floor layouts with appropriate labeling and locations of workstation Telecommunications Outlet (TO), Equipment Room/Telecommunications Room (ER/TR), Main Cross Connect/Intermediate Cross Connect (MC/IC), cable routes, interconnect locations, riser locations, and all other information pertinent to the installation.

B. Successful bidder will be responsible for accurately labeling and identifying all relevant components of the cabling system, including, but not limited to: TO face plate labeling; patch panel and block labeling and color-coding; backbone cable labeling at entrance to MC, BEF/IC/ER, and HC/TR; fiber optic patch panel labeling and color-coding, cables at each end, conduits at each end, and grounding system. The successful bidder will consult with CSI's representative regarding labeling and identification.

1.8 MATERIALS

The Telecommunications contractor must be an approved Certified Installer for the system installed. The Telecommunications contractor is responsible for workmanship and installation practices in accordance with a 25-year warranty to the end user once the Telecommunications contractor fulfills all requirements.

Bidder should expect to present quotes based on the following manufacturer's products. The horizontal workstation structured cabling system shall be an Ortronics. Bidder shall be authorized and certified, by the manufacturer's representative, to install, certify, and warranty, the structured cabling system. The specified Ortronics solution is substitutable with 10-day prior approval.

A. Horizontal Workstation Cable:
1. Superior Essex, CMP, Category 6, 4 twisted pair, 23 AWG, Station Wire for Plenum air return systems.

	Flame Rating	Jacket	Color	Part No.
a.	CMP Plenum	PVC Alloy	Orange	Superior-Essex CMP-77273DB
b.	Analog phone Plenum	PVC Alloy	White	Superior-Essex CMP-772734B

2. NOTE: Irrespective of air handling space, CSI requires the use of CMP Plenum rated cable for smoke and fire mitigation.

B. Workstation Telecommunications Outlet (TO):

	Description	Part No.
1.	CommScope Giga speed XL	MGS400-270 Gray Jack
2.	Analog phone Cat 5e	UNJ500-IV Ivory

C. Patch Panel Data Termination

Description	Ports	Part No.

3.	Ortronics	48	OR-PHD66U48

D. Patch Cords:

	Description	Length	Part No.
1.	Blue, 4-pair	3 ft.	OR-MC603-06
		5 ft.	OR-MC605-06
		7 ft.	OR-MC607-06
		9 ft.	OR-MC609-06
		15 ft.	OR-MC615-06
		20 ft.	OR-MC620-06
		25 ft.	OR-MC625-06

E. IT Rack

	Description	Part No.
1.	Ortronics	MM107SVR 4 post

F. Other-
1. CommScope M11SP single port stainless steel faceplates
2. Panduit HLT21-XO Black Velcro 8" Tie Wrap, 10 pack.
3. ERICO, Inc., CADDY Cable Cat Fasteners ("J" Hooks).
4. Carlon CF4X1C-5200 corrugated FEP orange inner duct.

PART 2 - CABLE PLANT

2.1 EQUIPMENT AND TELECOMMUNICATIONS ROOM REQUIREMENTS

A. No Intra or Inter-building telecommunications cable shall be run adjacent and parallel to the power cabling. A minimum of 5" distance is required from any fluorescent lighting fixture or power line up to 2kVA and 24" from any power line over 5kVA. Similarly, cable should be routed and terminated as far as possible from sources of EMF, such as ballasts, generators, fans, motor control units, motors, etc.

B. The HC/TR structured cable system shall be constructed using materials as specified in the materials list. Horizontal station cable, riser cables, and fiber optics shall be terminated in the appropriate location on the racking system. Voice cables shall be terminated on the appropriate 110 system. Data cables shall be terminated in the appropriate patch panels. Fiber optics shall be terminated in the appropriate fiber optic termination assembly. Cable termination, order of termination, color-coding, grouping, numbering plan, and labeling shall be performed in accordance with BICSI TDMM Chapter 14 Telecommunications Administration and CSI conventions. Entrance facilities shall be terminated on the backboard with appropriate building entrance protection as specified by CSI. The riser shall be extended from the backboard building entrance protection panel to the 110 system on the rack. Coordinate with a representative of CSI prior to installation of BEF/IC/ER and HC/TR distribution and termination hardware.

2.2 PATHWAY SUPPORT SYSTEM

A. All horizontal cables shall be installed using a home-run configuration. Conduit, cable tray or "J" hooks are acceptable in any combination to support the cable system.
   1. NOTE: In open ceiling environments, where cable is intentionally or unintentionally exposed to view, the cable shall not be painted,
      a. Cable should be protected from exposure to paint.
      b. Paint products may deteriorate the cable sheath and compromise the integrity of cable conductors.

B. Conduits shall be dedicated, using no smaller than a 3/4" inside diameter per workstation outlet. There shall be no daisy-chain conduit runs. Each location shall require one 3/4" conduit, which is a home run back to the appropriate HC/TR or appropriate tray/support system. Provide pull boxes in telecommunications conduit runs spaced not greater than 100 feet apart with no more than two right angle bends. If more than two bends are in any 100-foot section, increase the conduit by one trade size. See TIA/EIA- 569-A Section 4.4. Place a “TELECOMMUNICATIONS” label on all pull and junction boxes. If a cable tray system is installed, the conduit shall be a home run from the workstation outlet jack to the tray. Conduit runs shall not exceed 40% fill capacity and bend design as specified in TIA/EIA-569-A documents. Conduits should be sized appropriately.
   1. Conduit runs shall have no more than (2) right angle bends.
   2. Conduit fill shall not exceed 40%.

C. Traditional nylon synch style Tie Wraps shall not be used to bundle cables. Velcro style Tie Wraps are the only acceptable method to secure cable bundles. See materials list. At no time shall pulling tension exceed 25 lbs. on horizontal cables. Exceeding the maximum recommended pulling tension on Category 6 cables will compromise cable integrity. If wire integrity is compromised, the wire may not pass testing and certification standards required for a 1000BaseTX infrastructure. The installation contractor will be responsible for the replacement of any cable system that does not meet required standards.

D. No intra/inter-building telecommunications cable shall be run adjacent and parallel to the power cabling. A minimum of 5" distance is required from any fluorescent lighting fixture or power line up to 2kVA and 24" from any power line over 5kVA. Similarly, cable should be routed and terminated as far as possible from sources of EMF, such as generators, motors etc.

2.3 GLOSSARY

A. BDF Building Distribution Frame

B. BEF Building Entrance Frame

C. BET Building Entrance Termination

D. BICSI Building Industry Consulting Service International ER Equipment Room

E. HC Horizontal Cross Connect

F. IC Intermediate Cross Connect

G. IDF Intermediate Distribution Frame

H. MC Main Cross Connect

I. MDF Main Distribution Frame

J. RCDD Registered Communications Distribution Designer TO Telecommunications Outlet

K. TR Telecommunications Room

L. UTP Unshielded Twisted Pair

M. FO Fiber Optics

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install building structured wiring systems in accordance with manufacturer's written instructions and with recognized industry practices.

3.2 TESTING

A. Testing is required in accordance with these specifications to determine that installation conforms to industry standards.

B. Testing reports shall be furnished to the owner.

END OF SECTION 271343

DIVISION 28 ELECTRONIC SAFETY AND SECURITY

SECTION 28 13 00

ACCESS CONTROL SOFTWARE AND DATABASE MANAGEMENT

PART 1 - GENERAL

1.1 RELATED WORK

A. Division 08 - Door Hardware

B. Section 282300 – Video Surveillance

1.2 DEFINITIONS

A. ACS – Access Control System

B. CSA – Client Software Application

C. DGM – Dynamic Graphical Maps

D. ALPR – Automatic License Plate Recognition

E. SDK – Software Development Kit

F. GLM – Genetec Lifecycle Management

G. SSM – Server Software Module

H. UI – User Interface

I. USP – Unified Security Platform

J. USW – Unified Web Client

K. VMS – Video Management System

1.3 PROJECT LICENSING WORKSCOPE

A. Genetec licensing:
   1. Existing Genetec support licensing has expired. CSI requests all access control licenses, video management licenses, camera licenses to be brought current as

part of this project. At the end of the project all licenses are issued such that all licenses have the same renewal date.

2. CSI would like to include a lock down license and part of this project work scope.

1.4 QUALIFICATIONS

A. The system programmer will have attended manufacturer training and obtained certification in Genetec™ Security Center - Synergis™ Technical Certification.

B. Optionally, the system programmer will have attended manufacturer training and obtained certification in Genetec Security Center - Enterprise Technical Certification.

C. The system programmer shall be a Genetec certified partner with the following level of qualification:
   1. Elite Reseller or better

D. The system programmer shall submit proof of certifications.

PART 2 - PRODUCTS

2.1 NEW SYSTEM WORK SCOPE

A. College of Southern Idaho has an existing Genetec Security Center Synergis access control and security camera system. This system is connected to the main server and video management system located in the campus main distribution frame located in the Desert building IT room. See site electrical drawings for conduit duct bank routing between buildings.

B. Contractor shall provide and install all, but not limited to, servers, power over ethernet + network switches, (Hewlett Packard Enterprise HPE office connect 1920 series, or current model) cabling, pathways, raceways, cable trays, related to this system such that the end results is a complete functional system.

C. Contractor shall provide maps, set-up, configure, and program new building Genetec Security Center Synergism access control and security camera system. In a manner to minimize the amount of time required by College of Southern Idaho staff to onboard new system.

D. Access control system door hardware components integrated in lock sets, handle sets, shall be purchased through the access control integration contractor to alleviate issues arising from installation and product warranty requirements. Contractor shall coordinate access control system door hardware components procurement responsibilities with door hardware supplier.

2.2 ELECTRONIC ACCESS CONTROL SYSTEM GENERAL REQUIREMENTS

A. The existing ACS is an enterprise class IP access control software solution. It is fully embedded within a Unified Security Platform (USP). The USP allows the seamless unification of the ACS with an IP video management system (VMS).

B. The existing ACSl supports an unrestricted number of logs and historical transactions (events and alarms) with the maximum allowed being limited by the amount of hard disk space available.

C. The existing ACS supports a variety of access control functionalities, including but not limited to:
   1. Controller (Unit) management, door management, elevator management, and area management.
   2. Cardholder and cardholder group management, credential management, and access rule management.
   3. Badge printing and template creation.
   4. People counting, area presence tracking, and mustering.
   5. Offering a framework for third party hardware integration such as card and signature scanner.

D. Access Control Hardware Manufacturer:
   1. Genetec Security Center:
      a. Existing Synergis Enterprise system
         Provide Seneca Reliance 200 series server or current model.

   2. Flex Power Door Control Cabinet
      a. Provide FPO series, size as required for new system plus 50% spare capacity.

   3. Mercury Security Intelligent Door Control Cards
      a. LP1502 or current model quantity as required for new system.

   4. Mercury Security Serial I/O 16-Input Interface Panel
      a. MR16IN or current model quantity as required for new system.

   5. Hummingbird Networks
      a. J4858C-HN (HP Compatible) SFP or current model quantity as required for new system.

   6. Uninterruptible Powe Supply
      a. APC Smart-UPS (SMT750RM2UC) or current model quantity as required for new system.

   7. Patch panel
      a. Trendnet TC-P24Cs or current model quantity as required for new system.

   8. Horizontal Cable Management Tray
      a. TrippLite SRCABLETRAY1U SmartRack 1U or current model quantity as required for new system.

9. Patch panel
    a. Trendnet TC-P24Cs or current model quantity as required for new system.

10. Back up Batteries
    a. PowerSonic PW-PS1270F2 or current model quantity as required for new system.

11. Multi Technology Readers
    a. Schlage MT11 quantity as required for new system.

12. Wireless Door Contacts
    a. Inovonics EN4204R 4-Zone Receiver w/ Relay Outputs or current model quantity as required for new system.
    b. Inovonics EN1210W Wireless Door Contact / Transmitter or current model quantity as required for new system.
    c. W-Box 0E-DC4811 overhead door mounting bracket or current model quantity as required for new system.

13. Wired Door Contacts
    a. Interlogix 1076C-M ¾" Recessed Contact Inovonics EN1210W Wireless Door Contact / Transmitter bracket or current model quantity as required for new system.
    b. W-Box 0E-DC4811 overhead door mounting bracket or current model quantity as required for new system.

14. Schlage 9651T Thin Keyfobs
    a. Provide a 300 thin keyfobs to CSI for owner programming. Quantity as required for new system.

15. Access control cables.
    a. Windy City Wire 4461060 / ACS Composite (Green)
    b. Windy City Wire 5566080 / 23-4P Cat6 (Gray)
    c. Windy City Wire 002393-50 / 18-10 ACS (Purple)

E. Certification
1. The existing ACS is certified.
    a. UL-294
    b. ULC-S319
    c. EN-60839-11-1
    d. CSPN

2.3 ACS ACCESS MANAGEMENT

A. The existing ACS is based on an open architecture able to support multiple access control hardware manufacturers. The ACS is be able to integrate with multiple non-proprietary interface modules and controllers, access readers, and other third party applications.

B. The existing ACS is IP enabled solution. All communication between the ACS and hardware controllers are be based on standard TCP/IP protocol.

C. Access Manager Role
   1. The Access Manager Role is the server that synchronizes all access control hardware units under its control, such as door controllers and I/O modules. It is also be able to validate and log all access activities and events when the door controllers and I/O modules are online.
   2. The Access Manager Role maintains the communication link with the hardware controllers under its control. It also continuously monitors whether the controllers are online or offline.
   3. Synchronization of hardware units are automated and transparent to users and will occur in the background. It is also possible to manually synchronize units or to synchronize units on a schedule.
   4. The Access Manager Role supports doors and controllers located within one or more facilities. The Access Server supports a minimum of 200 readers and up to 2000 readers per computer.

D. The Access Server stores all access events associated with the doors, areas, hardware zones (hardware input points), elevators, and controllers under its direct control.

2.4 EXISTING ACS HARDWARE COMPATIBILITY LIST

A. The ACS has an open architecture that supports the integration of third party IP-based door controllers and I/O modules. The ACS simultaneously supports mixed configurations of access control hardware from multiple vendors.

B. The ACS supports SAM onboard to hold Desfire encryption keys.

C. The ACS supports 802.1x authentication.

D. The ACS supports embedded certificate validation engine.

E. The ACS supports the use of TLS 1.2 and certificates.

F. The ACS supports OSDP transparent reader mode to read Desfire credentials.

G. The ACS supports multiple types of hardware devices: single-reader controllers, 2-reader controllers, 1- to 64-reader controllers, integrated readers and door controllers, and Power-over-Ethernet (PoE) enabled door controllers.

H. The ACS supports most industry standard card readers that output card data using the Wiegand protocol and Clock-and-Data.

I. The ACS supports the following IP-enabled controllers. For a description of the capabilities of the controller, refer to the specific controller's A&E specifications and design:
   1. Synergis Master Controller

2. Synergis Cloud Link
3. Synergis IX
4. SharpV
5. HID VertX
6. HID VertX EVO
7. HID Edge
8. HID Edge EVO
9. PW6000 controllers
10. Mercury EP controllers
11. Mercury LP controllers
12. Mercury SIO module
13. Mercury M5 Bridge
14. Mercury MS Bridge
15. Assa Abloy Aperio RS485 8 to 1 hub
16. Assa Aperio AH40 (IP) hub
17. Assa Abloy IP Locks (no DSR required)
    a. Corbin Russwin
    b. Sargent Passport
    c. Sargent Profile
    d. IN220
18. Salto Sallis RS485 and PoE routers
19. Schlage AD-300 and AD-400 electronic locks
20. Schlage Control wireless lock
21. Schlage LE Networked wireless Mortise lock
22. Schlage NDE Networked wireless lock
23. Axis A1001
24. Axis A1601
25. STid RS485 readers
26. DDS AS34/TPL4
27. SimonsVoss Smart Intego

J. The following USB enrollment readers are supported:
   1. RF Ideas pcProx HID USB reader for enrolling proximity cards

2.5 EXISTING SEAMLESS UNIFICATION WITH VMS

A. Through the USP, the ACS supports integration with an IP Video Surveillance System or MVS. Integration with an IP video surveillance system permits the user to view live and recorded video.

B. Users are be able to associate one or more video cameras to the following entity types: doors, elevator and hardware zones (input points), and more.

C. The Monitoring UI presents a true Unified Security Interface for access control and video surveillance. Advanced live video viewing and playback of archived video is available through the Monitoring UI.

D. It is possible to view video associated with access control events when viewing a report.

2.6 EXISTING ACS CONTROLLER (UNIT) MANAGEMENT

A. The ACS supports the discovery, configuration, and management of IP enabled controllers and I/O modules (hardware units). A user is permitted to add, delete, or modify a controller if they have the appropriate privileges.

B. The ACS supports unit configuration through a preconfigured door template.

C. The ACS supports automatic unit discovery. The user can establish the settings for discovery ports and for the types of unit discovery and the ACS will automatically detect all connected devices.

D. The ACS supports a unit swap utility for swapping out an existing controller with a new controller. The unit swap utility will avoid the reprogramming of the system whenever a unit is replaced. All logs and events from the old unit are to be maintained.

E. The ACS supports pre-configuration of the system prior to the physical hardware installation.

F. The ACS supports Firmware upgrade in bulk from the application.

2.7 EXISTING ACS CARDHOLDER AND CARDHOLDER GROUP MANAGEMENT

A. The ACS supports the configuration and management of cardholders and cardholder groups. A user is able to add, delete, or modify a cardholder or cardholder group if they have the appropriate privileges.

B. Custom fields are supported for both cardholders and cardholder groups.

C. The ACS permits the following activation/expiration options for a cardholder’s profile: delayed activation of a cardholder’s profile, expiration based on the date of first use of credentials, or expiration on a user-defined date.

D. It is possible to set a start date and expiration date for the association of a cardholder and an access rule for temporary access.

E. It is possible to associate a picture to a cardholder’s profile. The picture needs to be imported from a file, captured with a digital camera, or captured from a video surveillance camera. When a cardholder event occurs, the picture of the cardholder will be displayed in the Monitoring UI. The ACS supports multiple standard picture formats.

F. Cardholder groups enable the grouping of cardholders to facilitate mass changes to system settings. It is possible to assign cardholder groups to access rules, thus avoiding the assignment of one cardholder at a time.

G. It is possible to search by picture association, custom fields, names, and credential codes.

H. It is possible to select multiple cardholders for immediate deactivation or reactivation.

I. The ACS supports the synchronization of cardholders and cardholders group through Active Directory including the credentials and pictures of the cardholders. It is possible to import cardholders from Azure AD.

J. It will support the ability to track unused credentials for x days.

2.8 EXISTING ACS CREDENTIAL MANAGEMENT

A. The ACS supports the configuration and management of credentials, for example access cards and keypad PIN numbers. A user is able to add, delete, or modify a credential if the user has the appropriate privileges.

B. The ACS supports reader transparent mode.

C. Users are able to add Custom Fields (user-defined fields) to credentials. Creating a new credential can be accomplished either manually or automatically.

D. Automatic creation will allow the user to create a credential entity by presenting a credential to a selected reader. The ACS will read the card data and associate it to the credential entity. It is possible to automatically enroll any card format.

E. The ACS will support high assurance credentials using validation of a certificate.

F. The ACS supports multiple credentials per cardholder without necessitating duplicate cardholder information. The ACS automatically detects and prevent attempts to register an already-registered credential.

G. It is possible to natively encode Desfire credentials from the user interface using customer’s own keys and configuration.

H. Batch enrollment of credentials is supported.

I. The ACS provides a workflow for badge issuance and card requests.

J. It is possible to support natively PIV credential in the system.

K. The ACS supports the use of license plates as a credential.

L. The ACS supports duress pin.

M. The ACS natively supports the creation and management of mobile IDs in the same way as other credentials.

2.9 EXISTING ACS CUSTOM CARD FORMATS

A. A custom card format feature will allow the administrator to add additional custom

card formats using an intuitive tool within the Configuration UI. The custom card format tool are flexible in the following ways:

1. Once enrolled, new custom card formats will appear in the card format lists for manual card enrollment.
2. An unrestricted number of additional custom card formats can be added.
3. Supports credential with up to 256 bits.
4. The administrator is able to set the following options when defining a new format:
   a. The order in which card fields appear in the user interface or CSA.
   b. Whether a field is hidden from or visible to an operator.
   c. Whether a field is read only or modifiable by an operator.
   d. Complex parity checking schemes.
   e. The order and location of a field's data. Location can be defined on a bit-by-bit basis.
   f. Application ID and keys for Desfire EV1 credentials.

2.10 EXISTING ACS BADGE DESIGNER

A. The badge designer will allow the creation of badge templates that define the content and presentation format of a cardholder badge to be printed.

B. Badge production consists of selecting the credential, the badge template, and clicking print.

C. Batch printing of cards is available.

D. The contents of a badge template can include: cardholder's first and last name, picture, custom fields, bitmap graphics, lines, ovals, rectangles, dynamic text labels linked to custom fields and static text labels, and barcodes (Interleaved 2 of 5, Extended Code 39).

E. Copy and paste of badge template objects is available.

F. It is possible to set the border thickness and color, the fill color of badge objects (content), and the color of text labels.

G. Settings, such as object transparency, text orientation, and auto-sizing of text is available or transparent to the user.

H. Supported badge formats is (portrait and landscape): CR70 (2.875" x 2.125"), CR80 (3.37" x 2.125"), CR90 (3.63" x 2.37"), CR100 (3.88" x 2.63"), and custom card sizes.

I. Dual-sided badges is supported.

J. A badge template import and export function is available to allow the sharing of badge templates between distinct or independent ACS.

K. Chromakey is supported.

2.11 EXISTING ACS DOOR MANAGEMENT

A. The ACS supports the configuration and management of doors. A user is able to add, delete, or modify a door if they have the appropriate privileges.

B. The ACS permit multiple access rules to be associated to a door.

C. It is possible to unlock all doors from an area at once.

D. The ACS supports the following forms of authentication: Card Only, Card or Keypad (PIN), or Card and Keypad (PIN). It is possible to define a schedule for when Card Only or Card and Keypad authentication modes is required.

E. It is possible to set an extended grant time on a per-door basis (in addition to the standard grant time). Cardholder properties includes the option of using the extended grant time. When flagged cardholders are granted access, the door is unlocked for the duration of the extended grant time instead of the standard grant time.

F. The ACS allows the configuration of the relocking mode on doors such as on door open, after a definite time, or on door close.

G. The ACS supports the ability to enforce the use of two valid reads from different cardholders to grant access to an area.

H. The ACS supports the ability to enable access rules for other cardholders once a supervisor has accessed an area.

I. The ACS supports the ability to enable unlocking schedule on a door once an employee has entered the facility.

J. Reader less doors.
   1. The ACS supports doors configured solely with a lock, a REX, and a door contact but without readers.
   2. The implementation of a reader-less door is possible with the use of standard access hardware IO modules. External hardware, such as timers, are not required.
   3. Unlocking schedules is programmable for reader less doors.
   4. Standard door activity reports are possible with reader less doors.

K. Unlocking schedules and exceptions to unlocking schedules is associated with a door. An unlocking schedule will determine when a door is automatically unlocked. The ACS supports the use of a specific offline unlocking schedule. Exceptions to unlocking schedules are used to define time periods during which unlocking schedules are not applied, such as during statutory holidays.

L. The ACS supports one or more cameras per door. Video will then be associated to door access events, such as access grant or access denied.

2.12 EXISTING ACS ELEVATOR MANAGEMENT

A. The ACS supports the configuration and management of elevators. A user can add, delete, or modify an elevator if they have the appropriate privileges.

B. The ACS is able to control access to specific floors using a reader within the elevator cab. Control is available through the use of a controller with an interface to a reader and to multiple output modules with relays.

C. Elevator floor selections is tracked using a controller with an interface to multiple input modules. Floor tracking is available within an elevator activity report.

D. The elevator control module will continue to function in offline mode if communication between the ACS and the controller fail.

E. The ACS supports one or more cameras per elevator cab. Video will then be associated to elevator access events, such as access granted or access denied.

2.13 EXISTING ACS PEOPLE COUNTING & AREA PRESENCE TRACKING (MUSTERING)

A. The ACS supports people counting (or area presence tracking). The ACS is able to monitor and report the number of cardholders in an area in real-time and for all areas. Monitoring is based on the entire access control infrastructure, for both local areas and those in remote geographic locations. People counting can also be used to perform mustering.

B. It is possible to control the maximum occupancy of an area by setting a threshold and user notification when reaching the limit.

C. The ACS will report area presence counts in the UI. Area presence tracks will dynamically track the total number of cardholders in an area. Displayed data is updated dynamically.

D. The ACS supports mustering through the use of mobile readers (requires additional software and hardware from third-party).

E. The ACS provides a native dedicated mustering task using a USB, mobile, or wall reader.

F. The ACS is able to generate an area presence report listing the cardholders located in one or more areas, accessible through the Monitoring UI. It is possible to filter the report by area and time period. The report also includes activity from sub-areas (nested areas).

G. Through people counting, the ACS is able to generate First Person In and Last Person Out events. The First Person In event will be detected when the first cardholder enters an empty area. The Last Person Out event will be detect when the last cardholder leaves an area. It is possible to trigger actions from both events such as sending a message or triggering an alarm.

H. The ACS is able to determine the entry of a cardholder based on a dedicated sensor.

2.14 EXISTING ACS CUSTOM FIELDS (USER-DEFINED FIELDS)

A. The ACS permits the creation of custom fields. Up to 1,000 custom fields is supported.

B. Custom fields is supported for the following entities: cardholders, cardholder groups, credentials, and visitors.

C. Supported custom fields includes text, integers, decimal numbers, dates, Boolean, and images (graphics).

D. Users is able to define a default value for a custom field.

E. The creation of new custom field types is possible. New custom field types is based on the standard custom fields supported. They supports user-defined values from which an operator must make a selection.

F. Administrators have the ability to define which users can view and modify specific custom fields. This limits the access to custom field data to users with pre-defined privileges. The ACS supports querying and report generation using custom fields.

G. Custom fields can be grouped and ordered within these groups as defined by the user.

H. Values for custom fields can be imported using the Import Tool.

2.15 EXISTING ACS IMPORT TOOL

A. The ACS supports an integrated Import Tool to facilitate the import of existing cardholder and credential data. The import of data is through the use the CSV file format. The tool is available from the Configuration UI.

B. The Import Tool supports the ability to manually import data that has been exported from a third party database if it is in CSV format.

C. The import tool permits the import of the following data:
   1. Cardholder name, descriptions, picture, email, and status.
   2. Cardholder group information.
   3. Credential name, status, format, and card number (including credentials with custom formats).
   4. Partition information.
   5. Custom fields.
   6. Activation date and expiration date.
   7. Update cardholder group association.

D. Full flexibility in selecting the fields to be imported during an import session is

available.

E. The option to use a custom and unique cardholder key is specified during the import process to ensure that cardholders with duplicate names will not have their data overwritten. Cardholder key generation is automated. The end user will have the option to select which fields will be used to create this unique key, for example credential number, custom fields, or cardholder name.

F. The ACS supports re-importing a CSV file containing new information to update existing information in the ACS database. Re-importing will enable bulk amendments to existing access control data.

2.16 EXISTING GENERAL CLIENT SOFTWARE REQUIREMENTS

A. The Client Software Applications (CSA) provides the user interface for USP configuration and monitoring over any network and be accessible locally or from a remote connection.

B. The CSA consists of the Configuration UI for system configuration and the Monitoring UI for monitoring. The CSA is Windows-based and provide an easy-to-use graphical user interface (UI).

C. The CSA for monitoring supports running in 64-bit mode.

D. The Server Administrator is used to configure the server database(s). It is web-based and accessible locally on the SSM or across the network.

E. The CSA will seamlessly merge access control, license plate recognition (ALPR), and video functionalities within the same user application.

F. The USP will the latest user interface (UI) development and programming technologies such as Microsoft WPF (Windows Presentation Foundation), the XAML markup language, and the .NET software framework.

G. All applications provides an authentication mechanism, which verifies the validity of the user. As such, the administrator (who has all rights and privileges) can define specific access rights and privileges for each user in the system.

H. Logging on to a CSA is done either through locally stored USP user accounts and passwords or using the operator’s Windows credentials when Active Directory integration is enabled. Additional license required for Active Directory.

I. When integrated with Microsoft’s Active Directory, the CSA and USP will authenticate users using their Windows credentials. As a result, the USP will benefit from Active Directory password authentication and strong security features Additional license required for Active Directory.

J. The CSA supports multiple languages, including but not limited to the following: English, French, Arabic, Czech, Dutch, German, Hebrew, Hungarian, Italian,

Japanese, Korean, Norwegian, Persian (Farsi), Polish, Portuguese (Brazilian), Simplified and Traditional Chinese, Russian, Spanish, Swedish, Thai, Turkish, and Vietnamese.

K. To enhance usability and operator efficiency, the Configuration UI and Monitoring UI supports many of the latest UI such as:
   1. A customizable Home Page that includes favorite and recently used tasks.
   2. Task-oriented approach for administrator/operator activities where each type of activity (surveillance, visitor management, individual reports, and more) is an operator task.
   3. Consolidated and consistent workflows for video, ALPR, and access control.
   4. Single click functionality for reporting and tracking. The Monitoring UI supports both single-click reporting for access control, ALPR, and video, as well as single-click tracking of areas, cameras, doors, zones, cardholders, elevators, ALPR entities, and more. Single-click reporting or tracking will create a new task with the selected entities to report on or track.

L. Configuration UI and Monitoring UI Home Page and Tasks
   1. The Configuration UI and Monitoring UI is task-oriented.
   2. A task is user interface design patterns whose goal is to simplify the user interface by grouping related features from different systems such as video and access, in the same display window. Features is grouped together in a task based on their shared ability to help the user perform a specific task.
   3. Tasks is accessible via the Home Page of either the Configuration or the Surveillance CSA.
   4. Newly created tasks is accessible via the Configuration UI or the Monitoring UI taskbar.
   5. Similar tasks is grouped into the following categories:
      a. Operation: Access control management, LRP management, and more.
      b. Investigation: access control activity reports, visitor activity reports, alarm reports, and more.
      c. Maintenance: Access control, troubleshooters, audit trails, health-related reports, and more.
   6. An operator is able to launch a specific task only if they have the appropriate privileges.
   7. The Home Page content is customizable through the use of privileges to hide tasks that an operator will not have access to and through a list of favorite and recently used tasks. In addition, editing a USP XML file to add new tasks on the fly will also be possible.

M. The Contractor provides up to 40 of simultaneous Clients.

2.17 EXISTING CONFIGURATION USER INTERFACE (UI)

A. General
   1. The Configuration UI application will allow the administrator or users with appropriate privileges to change the system configuration. The Configuration UI provides decentralized configuration and administration of the USP system from

anywhere on the IP network.
2. The configuration of all embedded ACS, VMS, and ALPR systems is accessible via the Configuration UI.
3. The Configuration UI will have a home page with single-click access to various tasks.
4. The Configuration UI includes a variety of tools such as troubleshooting utilities, import tools, and a unit discover tool, amongst many more.
5. The Configuration UI includes a static reporting interface to:
   a. View historical events based on entity activity. The user is able to perform such actions as printing a report and troubleshooting a specific access event from the reporting view.
   b. View audit trails that show a history of user/administrator changes to an entity.
6. Common entities such as users, schedules, alarms, and many more, can be reused by all embedded systems (ACS, VMS, and ALPR).

2.18 EXISTING ACS CLIENT USER INTERFACE (UI)

A. The Monitoring UI will fulfill the role of a Unified Security Interface that is able to monitor video, ALPR, and access control events and alarms, as well as view live and recorded video.

B. The Monitoring UI provides a graphical user interface to control and monitor the USP over any IP network. It will allow administrators and operators with appropriate privileges to monitor their unified security platform, run reports, and manage alarms.

C. To enhance usability and operator efficiency, the Monitoring UI supports the following UI concepts:
   1. Dynamically adaptive interface that adjusts in real-time to what the operator is doing.
   2. Dynamic controls loaded with entity-specific widgets (for example, door and camera widgets).
   3. Use of transparent overlays that can display multiple types of data in a seamless fashion.
   4. Display tile menus and quick commands.
   5. Consolidated and consistent workflows.
   6. Tile menus and quick commands easily accessible within every display tile of the user workspace.
   7. Single click functionality for reporting and tracking. The Monitoring UI supports both single-click reporting for access control, ALPR, and video, as well as single-click tracking of areas, cameras, doors, zones, cardholders, elevators, ALPR entities, and more. Single-click reporting or tracking will create a new task with the selected entities to report on or to track.

D. Monitoring UI Home Page and Tasks
   1. Similar tasks is grouped into the following categories:
      a. Operation: Access control/LRP/video surveillance, visitor management, mustering, access control and video alarm monitoring, and more.

b. Investigation: Video bookmark/motion/archive reports, access control activity reports, visitor activity reports, alarm reports, ALPR activity reports, and more.
c. Maintenance: Access control and video configuration reports, troubleshooters, audit trails, and more.

E. Dynamically Adaptive UI, Controls section, and Widgets
1. The Monitoring UI will dynamically adapt to what the operator is doing. This is accomplished through the concept of widgets that are grouped in the Monitoring UI Controls section.
2. Widgets is mini-applications or mini-groupings in the Monitoring UI Controls section that let the operator perform common tasks and provide them with fast access to information and actions.
3. With a single click on an entity (for example, door or camera) the specific widgets associated to that entity appear and other non-relevant widgets disappear dynamically (instantly). Widgets will bring the operator information such as door status and camera stream information, as well as user actions, such as door unlock, PTZ controls, and more.
4. Specific widgets include those for a door, camera, alarm, zone, display tile, video stream (statistics), PTZ camera, and more.

F. Operator Workflows
1. A workflow is a sequence of operations an operator or administrator will execute to complete an activity. The “flow” relates to a clearly defined timeline or sequence for executing the activity.
2. The Monitoring UI is equipped with consistent workflows for the ALPR, video, and access control systems that it unifies.
3. Generating or printing a report, setting up or acknowledging an alarm, or creating an incident report will follow the same process (workflow) whether the operator is working with video, ALPR, or access control, or with both video and access control.

G. Each task within the Monitoring UI consists of one or more of the following items:
1. Event list.
2. Logical tree. Doors, cameras, zones, ALPR units, and elevators is grouped under Areas in a hierarchical fashion.
3. Entities list of all entities being tracked.
4. Display tiles with various patterns (1 x 1, 2 x 2, and more).
5. Display tile menu with various commands related to cameras, doors, PTZ, and tile controls.
6. Control section with widgets.

H. The Monitoring UI supports multiple event lists and display tile patterns, including:
1. Event/alarm list layout only
2. Display tile layout only.
3. Display tile and alarm/event list combination.
4. ALPR map and alarm/event list combination

I. User workspace customization

1. The user will have full control over the user workspace through a variety of user-selectable customization options. Administrators will be able to limit what users and operators can modify in their workspace through privileges.
2. Once customized, the user is able to save their workspace.
3. The user workspace is accessible by a specific user from any client application on the network.
4. Display tile patterns is customizable.
5. Event or alarm lists span anywhere from a portion of the screen up to the entire screen and is resizable by the user. The length of event or alarm lists is user-defined. Scroll bars enable the user to navigate through lengthy lists of events and alarms.
6. The Monitoring UI supports multiple display tile patterns (e.g. 1 display tile (1x1 matrix), 16 tiles (8x8 matrix), and multiple additional variations).
7. The Monitoring UI supports as many monitors as the PC video adapters and Windows Operating System are capable of accepting.
8. Additional customization options include: show/hide window panes, show/hide menus/toolbars, show/hide overlaid information on video, resize different window panes, and choice of tile display pattern on a per task basis.

J. The Monitoring UI provides an interface to support the following tasks and activities common to access control, ALPR, and video:
1. Monitoring the events from a live security system (ACS and/or VMS and/or ALPR).
2. Generating reports, including custom reports.
3. Monitoring and acknowledging alarms.
4. Creating and editing incidents and generating incident reports.
5. Displaying dynamic graphical maps and floor plans, as well as executing actions from dynamic graphical maps and floor plans.
6. Management and execution of hot actions and macros.

K. The Monitoring UI is able to monitor the activity of the following entities in real-time: areas, ALPR entities, doors, elevators, cameras, cardholders, cardholder groups, zones (input points), and more. The Monitoring UI provides an interface to support the following access control tasks and capabilities:
1. Monitoring and management of access events and alarms.
2. Viewing of cardholder picture or badge IDs.
3. Verification of cardholder picture IDs against live video.
4. Visitor management.
5. People counting or mustering, including resetting the people count in an area.
6. Door control, including remotely unlocking doors, overriding a door’s unlocking schedules, and enabling door maintenance mode.
7. Forgiving antipassback.
8. Generation of ACS configuration and activity reports.
9. Viewing of HTML files including alarm instructions.

L. Entity Monitoring
1. The USP permits the user to select multiple entities to monitor from the Monitoring UI by adding the entities one by one to the tracking list.
2. The Monitoring UI provides the option to filter which events is displayed in the

display tile layout, event list layout, or both.

3. It is possible to lock a Monitoring UI display tile so that it only tracks the activity of a specific entity (for example, a specific door or camera).
4. The user is able to drag and drop an event from an event list (or an alarm from an alarm list) onto a display tile to view a license plate read, cardholder picture ID, badge ID, or live/archived video, among other options.
5. Event, alarm, monitoring/tracking, and report lists contain cardholder pictures where applicable.
6. The user is permitted to start or pause the viewing of events within each display tile.

M. Display Tile Packing and Unpacking
1. The Monitoring UI supports single-click unpacking and packing for, areas, doors, zones, and alarms.
2. The packing and unpacking of entities allow operators to quickly obtain additional information and camera views of a specific entity.
3. The unpacking of an entity displays associated entities. For example, unpacking a door with multiple associated cameras displays all cameras associated with that door. Unpacking will reconfigure the display tiles to be able to display all associated entities. For example, unpacking a door (or a zone or alarm) that is currently in a 1 x 1 tile configuration and that has 3 cameras tied to it will create a 1 x 3 display tile arrangement for viewing all associated entities.
4. Packing will return the display to the original tile pattern.

N. The following additional tools or utilities is available from the Monitoring UI: create credentials, create cardholders, and access control troubleshooter.

2.19 EXISTING SERVER ADMINISTRATOR USER INTERFACE REQUIREMENTS

A. The Server Administrator is used to configure the SSM and the Directory Role (main configuration) and its database(s), to apply the license, and more.

B. The Server Administrator is a web-based application. Through the Server Administrator, it is possible to access the SSM across the network or locally on the server.

C. Access to the Server Administrator is protected via login name, password, and encrypted communications.

D. The Server Administrator allows the administrator (user) to perform the following functions:
1. Manage the system license.
2. Configure the database(s) and database server for the Directory Role.
3. Activate/Deactivate the Directory Role.
4. Manually back up the Directory Role database(s) and/or restore the server database(s), as well as configure scheduled backups of the databases.
5. Define the client-to-server communications security settings.
6. Configure the network communications hardware, including connection addresses and ports.

2.20 EXISTING UNIFIED WEB CLIENT (UWC) GENERAL REQUIREMENTS

A. The USP supports a unified web client (UWC) for access control, video, and automatic license plate recognition (ALPR).

B. The UWC is a truly thin client with no download required other than an internet web browser or standard web browser plugins.

C. The UWC is platform independent and run within Microsoft Internet Explorer, Firefox, Safari, and Google Chrome.

D. The UWC is designed as an HTML5 application.

E. The UWC supports display on tablet format.

F. The UWC will support native H.264 video in the web client.

G. Web pages for the web client is managed and pushed by the Web Client Server. Microsoft IIS or any other web hosting service will not be required given that all the web pages is hosted by the Mobile Server.

H. The Web Client Server provides the ability to define a unique URL to access the web client, to ensure the security of the application.

I. The UWC provides the ability to configure, save, and reload camera layouts.

J. The UWC provides the ability to control PTZ cameras.

K. Functionalities:
   1. Log in using name and password or Active Directory support is available. Ability for user to change its password.
   2. Encrypted communications for all transactions.
   3. Print reports and export to CSV file.
   4. Access Control.
      a. Cardholder and group (add/modify/delete)
      b. Credential management (modify/delete)
      c. Visitor management (check-in/modify/check-out)
      d. Unlock door
      e. Override the unlocking schedule on a door
      f. Door Activities report
   5. Alarms.
      a. Alarm report
   6. Threat Level management.
   7. Automatic License Plate Recognition (ALPR).
      a. Live monitoring of the ALPR cameras
      b. ALPR reads and hits report
      c. Addition of plate numbers to hotlists

2.21 EXISTING SMARTPHONE AND TABLET APP GENERAL REQUIREMENTS

A. The USP supports mobile apps for various off-the-shelf devices. The mobile apps will communicate with the USP over any Wi-Fi or cellular network connection.

B. Mobile apps will communicate with the USP via a Mobile Server Role (MSR). All communication between the mobile apps and MSR is based on standard TCP/IP protocol and will use the TLS encryption with digital certificates to secure the communication channel.

C. Supported device manufacturers includes (refer to Mobile App specifications for latest compatibility list):
   1. Apple devices running iOS 11.0 or later
   2. Android devices 6.0 or later

D. It is possible to download the mobile apps from the Central application store (Apple iTunes App Store, Google Play).

E. Functionalities
   1. Core
      a. Ability to logon/logoff the USP using an authorized use profile of the system.
      b. Ability to change the picture or the password of the user of the mobile app.
      c. Ability to view the current Threat Level of the system.
      d. Ability to change the current Threat Level of the system.
      e. Ability to execute hot actions configured in the user profile.
      f. Ability to view entities from the USP:
         1) Cameras
         2) Doors
         3) ALPR cameras
         4) Web Tile Plugins
         5) Layouts
         6) Camera Sequences
         7) Macros
      g. Ability to navigate the system hierarchical view of the entities and search entities in the system.
   2. Video
      a. Ability to view live and recorded video from the cameras of the USP. A maximum of four cameras is displayed.
      b. Ability to display live and recorded video side-by-side for a specific camera.
      c. Ability to perform digital zoom on cameras.
      d. Ability to perform actions on cameras, such as add a bookmark, control a PTZ, control the iris/focus function, save a snapshot, and start/stop recording.
      e. Ability to view camera layouts.
      f. Ability to view camera sequences.
      g. Ability to run a camera events report.
      h. Ability to change the video quality on the cameras displayed on the mobile app.
      i. Ability to use the camera of the smartphone and stream a live video feed to a video recorder in the system
   3. Access Control

a. Ability to view the door state and the door lock state.
b. Ability to perform actions on a door such as unlock the door, set the door in maintenance mode, and override the door unlocking schedule.

4. Automatic License Plate Recognition
   a. Ability to view live events raised by an ALPR camera.
   b. Ability to view the read image, context image, and all metadata captured by the ALPR camera.
   c. Ability to run an ALPR event report.
   d. Ability to add a license plate to a hotlist on the system.
5. Alarm Management
   a. Ability to receive push notifications to notify mobile operators that an alarm was received.
   b. Ability to view all active alarms assigned to the mobile operator.
   c. Ability to perform action on an alarm such as acknowledge, forward, or alternate-acknowledge an active alarm.
   d. Ability to view entities attached to the alarm.

F. It is possible to send a message from the client user interface to a mobile operator.

G. It is possible to send a live or playback video sequence from the client UI to a mobile operator.

2.22 EXISTING HEALTH MONITOR

A. The USP will monitor the health of the system, log health-related events, and calculate statistics.

B. USP services, roles, agents, units, and client apps will trigger health events.

C. The USP will populate the Windows Event Log with health events related to USP roles, services, and client apps.

D. A dedicated role, the Health Monitoring Role, will perform the following actions:
   1. Monitor the health of the entire system and log events.
   2. Calculate statistics within a specified time frame (hours, days, months).
   3. Calculates availability for clients, servers and video/access/ALPR units.

E. A Health Monitoring task and Health History reporting task is available for live and historical reporting.

F. A Health Monitoring dashboard task is available in the client application user interface to provide a live display, such as pie charts and event lists, for quick visual assessment on the general health of the system.

G. A web-based, centralized health dashboard is available to remotely view unit and role health events of the USP.

H. Detailed system care statistics will be available through a web-based dashboard providing health metrics of USP entities and roles, including Uptime and mean-time-

between-failures.

I. All health events raised in the system can be used for automating the USP event/action management.

J. Health events is accessible via the SDK (can be used to create SNMP traps).

2.23 USP GENERAL REQUIREMENTS

A. The Unified Security Platform (USP) is an enterprise class IP-enabled security and safety software solution.

B. The USP supports the seamless unification of IP access control system (ACS), IP video management system (VMS), and IP automatic license plate recognition system (ALPR) under a single platform. The USP user interface (UI) applications will present a unified security interface for the management, configuration, monitoring, and reporting of embedded ACS, VMS and ALPR systems, and associated edge devices.

C. Functionalities available with the USP includes:
   1. Configuration of embedded systems, such as ACS, ALPR, and VMS systems.
   2. Live event monitoring.
   3. Live video monitoring and playback of archived video.
   4. Alarm management.
   5. Reporting, including creating custom report templates and incident reports.
   6. Dynamic graphical map viewing.

D. The USP is deployed in one or more of the following types of installations:
   1. Unified access, ALPR, video platform, and any combination thereof.
   2. Standalone access control, video, or ALPR platform.
   3. Unified access and video platform that federates multiple remote ACS, VMS, and ALPR.
   4. Standalone access control that federates multiple independent remote ACS.

E. Licensing:
   1. A single central license is applied centrally on the configuration server.
   2. There is no requirement to apply a license at every server computer or client workstation.
   3. Based on selected options, one or more embedded systems is enabled or disabled.

F. Hardware and Software Requirements:
   1. The USP and embedded systems (video, license plate recognition, and access control) is designed to run on a standard PC-based platform loaded with a Windows operating system. The preferred operating system is coordinated with the Owner following the manufacturer supported operating systems.
   2. The core client/server software is built in its entirety using the Microsoft .NET software framework and the C# (C-Sharp) programming language.
   3. The USP database server(s) is built on Microsoft’s SQL Server. The preferred SQL version is coordinated with the Owner and compatible with the USP.

4. The USP is compatible with virtual environments, including VMware and Microsoft Hyper-V.
5. The USP will use the latest user interface (UI) development and programming technologies such as Microsoft WPF (Windows Presentation Foundation), the XAML markup language, and .NET software framework.

2.24 EXISTING USP ARCHITECTURE

A. The USP is based on a client/server model. The USP consists of a standard Server Software Module (SSM) and Client Software Applications (CSA).

B. The USP is an IP enabled solution. All communication between the SSM and CSA is based on standard TCP/IP protocol and will TLS encryption with digital certificates to secure the communication channel.

C. The SSM is a Windows service that can be configured to start when the operating system is booted and run in the background. The SSM will automatically launch at computer startup, regardless of whether or not a user is logged on the machine.

D. Users is able to deploy the SSM on a single server or across several servers for a distributed architecture. The USP will not be restricted in the number of SSM deployed.

E. The USP will protect against potential database server failure and continue to run through standard off-the-shelf solutions.

F. The USP supports an unrestricted number of logs and historical transactions (events and alarms) with the maximum allowed being limited by the amount of hard disk space available.

G. Roles-Based Architecture:
   1. The USP consists of a role-based architecture, with each SSM hosting one or more roles.
   2. Each role will execute a specific set of tasks related to either core system, automatic license plate recognition (ALPR), video (VMS), or access control (ACS) functionalities, among many others. Installation is streamlined through the ability of the USP to allow administrators to:
      a. Deploy one or several SSM across the network prior to activating roles.
      b. Activate and deactivate roles as needed on each and every SSM.
      c. Centralize role configuration and management.
      d. Support remote configuration.
      e. Move roles over from one SSM to another.
   3. Each role, where needed, will have its own database to store events and role-specific configuration information.
   4. Roles without databases, such as The Federation feature, Active Directory, and Global Cardholder Management, supports near real-time standby without any third party failover software being required.
   5. Directory Role:
      a. The Directory Role will manage the central database that contains all the

system information and component configuration of the USP.

b. The Directory Role will authenticate users and give access to the USP based on predefined user access rights or privileges, and security partition settings.
c. The Directory Role supports the configuration/management of the following components common to the ACS, ALPR, and VMS sub-systems:
    1) Security Partitions, users, and user groups
    2) Areas
    3) Zones, input/output (IO) linking rules, and custom output behavior
    4) Alarms. Schedules, and scheduled tasks
    5) Custom events
    6) Macros or custom scripts
d. The Directory Role supports the configuration/management of the following components specific to VMS:
    1) Video servers and their peripherals (for example audio, IOs, and serial ports)
    2) PTZ
    3) Camera sequences
    4) Recording and archiving schedules
e. The Directory Role supports the configuration/management of the following components specific to ACS:
    1) Door controllers, and input and output (IO) modules
    2) Doors, Elevators, and Access rules
    3) Cardholders and cardholder groups, credentials, and badge templates
f. The Directory Role supports the configuration/management of the following components specific to ALPR:
    1) ALPR units and cameras
    2) Hotlists, permit lists, and overtime rules

6. The Video Archiver Role is responsible for managing cameras and encoders under its control and archiving.
7. The Media Router Role is responsible for routing video and audio streams across local and wide area networks from the source (for example DVS) to the destination (for example CSA).
8. The Access Manager Role is responsible for synchronizing access control hardware units under its control, such as door controllers and I/O modules. This role will also be responsible for validating and logging all access activities and events when the door controllers and I/O modules are online.
9. The Automatic License Plate Recognition (ALPR) Role is responsible for synchronizing fixed ALPR units (cameras) and mobile ALPR applications under its control. The ALPR Role will also be responsible for logging all ALPR activities and events.
10. The Zone Manager Role is responsible for managing all software zones (collection of inputs) and logging associated zone events. Zones consists of inputs from both access control and video devices.
11. The Health Monitoring Role is responsible for monitoring and logging health events and warnings from the various client applications, roles, and services that are part of the USP. This role will also be responsible for logging events within the Windows Event Log and for generating reports on health statistics and health history.

H. Server Monitoring Service (Watchdog):
1. The USP includes a Server Monitoring Service that continuously monitors the state of the Server Software Module (SSM) service.
2. The Server Monitoring Service is a Windows service that automatically launches at system startup, regardless of whether or not a user is logged into his account.
3. The Server Monitoring Service is installed on all PCs/servers running an SSM. In the event of a malfunction or failure, the Server Monitoring Service will restart the failed service. As a last resort, the Server Monitoring Service will reboot the PC/server if unable to restart the service.

2.25 EXISTING USP ACCESS CONTROL, VIDEO, AND ALPR UNIFICATION

A. The Monitoring UI will present a true Unified Security Interface for live monitoring and reporting of the ACS, VMS, and ALPR. Advanced live video viewing and playback of archived video is available through the Monitoring UI.

B. The Configuration UI will present a true Unified Security Interface for the configuration and management of the ACS, VMS, and ALPR.

C. The user is able to associate one or more video cameras to the following entity types: areas, doors, elevators, zones, alarms, intrusion panels, ALPR cameras, and more.

D. It is possible to view video associated to access control events when viewing a report.

E. It is possible to view video associated to intrusion panel events when viewing a report.

F. It is possible to view video associated to ALPR events when viewing a report.

2.26 EXISTING USP ALARM MANAGEMENT

A. The USP supports the following Alarm Management functionality:
1. Create and modify user-defined alarms. An unrestricted number of user-defined alarms is supported.
2. Assign a time schedule or a coverage period to an alarm. An alarm is triggered only if it is a valid alarm for the current time period.
3. Set the priority level of an alarm and its reactivation threshold.
4. Define whether to display live or recorded video, still frames or a mix once the alarm is triggered.
5. Provide the ability to display live and recorded video within the same video tile using picture-in-picture (PiP) mode.
6. Provide the ability to group alarms by source and by type.
7. Define the time period after which the alarm is automatically acknowledged.
8. Define the recipients of an alarm. Alarm notifications is routed to one or more recipients. Recipients is assigned a priority level that prioritizes the order of reception of an alarm.
9. Define the alarm broadcast mode. Alarm notifications is sent using either a sequential or an all-at-once broadcast mode.
10. Define whether to display the source of the alarm, one or more entities, or an

HTML page.

11. Specify whether an incident report is mandatory during acknowledgment.

B. The workflows to create, modify, add instructions and procedures, and acknowledge an alarm is consistent for access control, ALPR, and video alarms.

C. Alarms is federated, allowing global alarm management across multiple independent USP, ACS, and VMS systems.

D. The USP will also support alarm notification to an email address or any device using the SMTP protocol.

E. The ability to create alarm-related instructions is supported through the display of one or more HTML pages following an alarm event. The HTML pages is user-defined and can be interlinked.

F. Alarm unpacking and packing is supported where all the entities associated to an alarm can be display in the Monitoring UI with the single click of a button.

G. The user will have the ability to acknowledge alarms, create an incident upon alarm acknowledgement, and put an alarm to snooze.

H. The user is able to spontaneously trigger alarms based on something he or she sees in the system.

I. An alarm is configured in such a way that it remains visible until the source condition has been acknowledged.

J. The user is able to investigate an alarm without acknowledging it.

2.27 EXISTING USP ADVANCED TASK MANAGEMENT

A. USP supports an infrastructure for managing Monitoring UI tasks used for live monitoring, day-to-day activities, and reporting.

B. Administrators is able to assign tasks and lock the operator’s workspace. The user management of their workspace is limited by their assigned privileges.

C. Operators is able save their tasks as either Public tasks or Private tasks and in a specific partition. Public tasks is available to all users. Private tasks will only be available to the owner of the task.

D. Operators is able to share their tasks by sending them to one or more online users. Recipients will have the option to accept the sent task.

E. Operators is able to duplicate a task.

2.28 EXISTING USP REPORTING

A. The USP supports report generation (database reporting) for access control, ALPR, video, and intrusion.

B. Each and every report in the system is a USP task, each associated with its own privilege. A user will have access to a specific report task if they have the appropriate privilege.

C. The workflows to create, modify, and run a report is consistent for access control, ALPR, and video reports.

D. Reports is federated, allowing global consolidated reporting across multiple independent USP, ACS, VMS, and ALPR systems.

E. Access control and ALPR reports supports cardholder pictures and license plate pictures, respectively.

F. The USP supports the following types of reports:
   1. Alarm reports
   2. Video-specific reports (archive, bookmark, motion, and more)
   3. Configuration reports (cardholders, credentials, units, access rules, readers/inputs/outputs, and more)
   4. Activity reports (cardholder, cardholder group, visitor, credential, door, unit, area, zone, elevator, and more)
   5. ALPR-specific reports (mobile ALPR playback, hits, plate reads, reads/hits per day, reads/hits per ALPR zone, and more)
   6. Health activity and health statistics reports
   7. Other types of reports, including visitor reports, audit trail reports, incident reports, and time and attendance reports

G. Generic Reports, Custom Reports and Report Templates:
   1. The user will have the option of generating generic reports from an existing list, generating reports from a list of user-defined templates, or creating a new report or report template.
   2. The user is able to customize the predefined reports and save them as new report templates. There is no need for an external reporting tool to create custom reports and report templates. Customization options includes setting filters, report lengths, and timeout period. The user will also be able to set which columns is visible in a report. The sorting of reported data is available by clicking on the appropriate column and selecting a sort order (ascending or descending).
   3. All report templates is created within the Monitoring UI.
   4. These templates can be used to generate reports on a schedule in PDF or Excel formats.
   5. An unrestricted number of custom reports and templates is supported.

H. A reporting task layout consists of panes with settings (report length, filters, go and reset commands, etc.), the actual report data in column format, and a pane with display tiles. The user is able to drag and drop individual records in a report onto one or more display tiles to view a cardholder’s picture ID, playback a video sequence, or an ALPR event.

I. The USP supports comprehensive data filtering for most reports based on entity type, event type, event timestamp, custom fields, and more.

J. The reporting task will have the ability to display results through graphics such as line charts, bar charts, stacked bar charts, doughnut charts, and pie charts.

K. The user is able to click on an entity within an existing report to generate additional reports from the Monitoring UI.

L. The USP supports the following actions on a report: print report, export report to a PDF/Microsoft Excel/CSV file, export the graphics chart in JPG/PNG, and automatically email a report based on a schedule and a list of one or more recipients.

2.29 EXISTING USP DASHBOARDS

A. The USP supports the ability to create dashboards.

B. Operators is allowed to view dashboards if they are granted the appropriate privilege. Modification to the dashboards will also be allowed to users granted the appropriate privilege.

C. Dashboards in the system is a USP task. A user will have access to a specific dashboard task if they have the appropriate privilege.

D. Dashboards is shaved either in a private folder or a public folder.

E. A dashboard consists of a canvas with various widgets displayed on the canvas. All widgets will offer the ability to specify location and size to the widget, a title to the widget, a background color to the widget, and the ability to refresh periodically the content of the widget.

F. Dashboard widget types is:
   1. Image: provides the ability to display an image (JPG, PNG, GIF, BMP) on a dashboard.
   2. Text: provides the ability to display a text on a dashboard. The text style is configurable, so font, size, color, and alignment can be specified by the user.
   3. Tile: provides the ability to display any entity of the USP inside of a tile.
   4. Web page: provides the ability to display a URL on a dashboard.
   5. Entity Count: provides the ability to display the total number of a specific entity type in the USP.
   6. Reports: provides the ability to display the results of any saved reports in the system. The results is displayed either by showing the total number of results in the report, a set of top results from the report, or a visual graph from the data returned by the report.

G. It is possible to extend the widgets of a dashboard using the SDK. This will provide the ability to develop custom widgets to the system.

H. The USP supports the following actions on a dashboard: print dashboard, export

dashboard to PNG file, and automatically email a report based on a schedule and a list of one or more recipients.

2.30 EXISTING USP ZONE MANAGEMENT

A. The USP supports the configuration and management of zones for input point monitoring via the Zone Manager Role. A user is able to add, delete, or modify a zone if they have the appropriate privileges.

B. A zone will monitor the status of one or more inputs points. Zone monitoring or input point monitoring is possible through the use of a controller and one or more input modules. Inputs from video cameras or video encoders will also be accessible via a zone.

C. Depending on the hardware installed, supervised inputs is supported. Depending on the input module used, both 3-state and 4-state supervision is available.

D. A schedule is defined for a zone, indicating when the zone will be monitored.

E. Custom Events provides full flexibility in creating custom events tailored to a zone. Users is able to associate custom events to state changes in monitored inputs.

F. The ACS supports one or more cameras per zone. Video will then be associated to zone state changes.

G. Input/Output (IO) Linking
   1. Zone management supports Input/Output (IO) Linking. I/O Linking will allow one or more inputs to trigger one or more outputs.
   2. I/O Linking is available in offline mode when communication between the server and hardware is not available.
   3. Custom Output Behaviors provides full flexibility in creating a variety of complex output signal patterns: simple pulses, periodic pulses, variable duty-cycle pulses, and state changes.
   4. Through the “trigger an output” action, the ACS supports the triggering of outputs with custom output behaviors.

2.31 EXISTING USP USER AND USER GROUP SECURITY, PARTITIONS, AND PRIVILEGES MANAGEMENT

A. The USP supports the configuration and management of users and user groups. A user is able to add, delete, or modify a user or user group if they have the appropriate privileges.

B. The USP supports user authentication with claims-based authentication using external providers. External providers includes:
   1. ADFS (Active Directory Federation Services)

C. Common access rights and privileges shared by multiple users is defined as User

Groups. Individual group members will inherit the rights and privileges from their parent user groups. User group nesting is allowed.

D. User privileges is extensive in the USP. All configurable entities for the USP, including access control, video, and ALPR will have associated privileges.

E. Specific entities, such as cardholders, cardholder groups, and credentials includes a more granular set of privileges, such as the right to access custom fields and change the activation or profile status of an entity.

F. Partitions:
   1. The USP limits what users can view in the configuration database via security partitions (database segments). The administrator, who has all rights and privileges, is allowed to segment a system into multiple security partitions.
   2. All entities that are part of the USP can be assigned to one or more partitions.
   3. A user who is given access to a specific partition will only be able to view entities (components) within the partition to which they have been assigned. Access is given by assigning the user as an accepted user to view the entities that are members of a particular partition.
   4. A user or user group can be assigned administrator rights over the partition.

G. It is possible to specify user and user group privileges on a per partition basis.

H. Advanced logon options is available such as dual logon and more.

I. It is possible to specify an inactive period for the Monitoring UI after which time the application will automatically lock, while still preserving access to currently displayed camera feeds.

J. It is possible to review used permissions and determine:
   1. For any entity in the system, which user group or user can view or modify it.
   2. For any user group or user in the system, what are its privileges.
   3. For any privilege in the system, which used group or used is allowed to perform the underlying action.

2.32 EXISTING USP EVENT/ACTION MANAGEMENT

A. The USP supports the configuration and management of events for video and ALPR. A user is able to add, delete, or modify an action tied to an event if he has the appropriate privileges.

B. The USP will receive all incoming events from one or more ACS, VMS, and/or ALPR. The USP will take the appropriate actions based on user-define event/action relationships.

C. The USP will receive and log the following events:
   1. System-wide events
   2. Application events (clients and servers)
   3. Area, camera, door, elevator, and ALPR events (reads and hits)

4. Cardholder and credential events
5. Unit events
6. Zone events
7. Alarm events
8. ALPR events
9. First Person In and Last Person Out events and antipassback events
10. Intrusion events
11. Asset management events
12. Health monitoring events.

D. The USP will allow the creation of custom events.

E. The USP will have the capability to execute an action in response to an access control, video, and ALPR event.

F. The USP will allow a schedule to be associated with an action. The action is executed only if it is an appropriate action for the current time period.

2.33 EXISTING USP SCHEDULES AND SCHEDULED TASKS

A. Schedules
1. The USP supports the configuration and management of complex schedules. A user is able to add, delete, or modify a schedule if they have the appropriate privileges.
2. The USP provides full flexibility and granularity in creating a schedule. The user is able to define a schedule in 1-minute or 15-minute increments.
3. Daily, weekly, ordinal, and specific schedules is supported.

B. Scheduled Tasks
1. The USP supports scheduled tasks for access control, video, and ALPR.
2. Scheduled tasks is executed on a user-defined schedule at a specific day and time. Recurring or periodic scheduled tasks will also be supported.
3. Scheduled tasks supports all standard actions available within the USP, such as sending an email or emailing a report.

2.34 EXISTING USP MACROS AND CUSTOM SCRIPTS

A. The USP will enable users to automate and extend the functionalities of the system through the use of macros or custom scripts for access control, video, and ALPR.

B. Custom macros is created with the USP Software Development Kit (SDK).

C. A macro is executed either automatically or manually.

D. In the Monitoring UI, a macro is launched through hot actions.

2.35 EXISTING USP DYNAMIC GRAPHICAL MAPS (DGM)

A. The USP supports mapping functionality for access control, video surveillance, intrusion detection, ALPR, and external applications.

B. The USP provides a map centric interface with the ability to command and control all the USP capabilities from a full screen map interface.

C. It is possible to span the map over all screens of the USP client station. In the scenario where the map is spanned over all the screens of the USP client station it is possible to navigate the map including pan and zoom, and the map's moves is synchronized between all screens. Spanning the map over multiple screen must provide the same command and control capabilities than in a single screen display.

D. The DGM supports the following file format and protocol for importing map background:
   1. PDF
   2. JPG
   3. PNG
   4. Web Tile Map Service (WMTS) and Web Map Service (WMS) defined by the Open Geospatial Consortium (OGC)
   5. BeNomad
   6. AutoCAD (DWG & DXF)

E. The DGM provides the following online map providers for use as map background and provide the ability to manage their service license if they require one:
   1. Google Map, aerial, terrain (Licensed)
   2. Bing Map, aerial, satellite, hybrid (Licensed)
   3. ESRI ArcGIS (Licensed)
   4. OpenStreet Map aerial (Licensed)
   5. OVI hybrid

F. It is possible to configure a mixed set of maps made of GIS, online providers and private imported files and link them together.

G. The DGM provides the ability to display all native entities of the USP including:
   1. Cameras, fix, and PTZ
   2. Doors
   3. Camera sequences
   4. Areas
   5. Intrusion areas
   6. Intrusion zones
   7. License Plate Recognition cameras
   8. Digital inputs
   9. Digital outputs
   10. Intercoms
   11. Alarms
   12. Macros
   13. Police Car Patrollers

H. The DGM provides the ability to draw and display information over the map in the form of:

1. Vectoral shapes: line, rectangles, polygons, ellipse
2. Pictures
3. Text

I. The DGM provides the ability to display layer of information in Keyhole Markup Language (KML) format.

J. The DGM provides the ability to the operator to manage layers of entities displayed over the map, being able to turn them on and off and changing the superposition order.

K. The DGM provides the ability to import data layers from one or more ESRI ArcGIS servers.

L. The DGM provides the operators with the ability to manage layers that are imported from ESRI ArcGIS. The operators is able to turn the layers on and off, as well as sort the layers.

M. The DGM will offer built-in map data backup and restore for both map backgrounds and layers of entities.

N. The DGM will offer failover capabilities.

O. The DGM will scale up to several thousands of entities on a single map and hundreds of maps.

P. The DGM provides a means to update a map background without affecting the map object configuration.

Q. The DGM will offer a user-friendly graphical map designer to configure the maps.

R. The DGM provides user friendly and intuitive navigation that includes:
1. The ability to create hierarchies of maps to facilitate navigation within and between various sites and buildings.
2. The ability to define favorites for recurrent position recall.
3. The possibility to create links between maps. The map links will allow the link from one map to multiple maps representing the floors of a building. Navigating between floors of a building will keep the level of the map.

S. It is possible to monitor the state of entities on the map. It is possible to customize the icons of any entities represented on the map.

T. The DGM will offer the ability to optionally set a graphical display notification of the motion detection.

U. The DGM will offer a smart selection tool to access the video. By clicking the location the user wants to see, the DGM will automatically select the cameras that can see this location and move the PTZ towards that location. This smart selection tool will take obstacles into consideration and not display cameras that cannot see the location because of a wall.

V. It is possible to select a location by drawing a zone of interest on the DGM, and to display all the entities that are part of that zone of interest at once.

W. The user is able to select and display the content of multiple USP entities on the map in pop-up windows.

X. The user is able to move, resize, and pin the USP entity pop-up windows to the map.

Y. It is possible to access live and playback video from the map.

Z. It is possible to monitor all entity event notifications from the DGM. Users is able to turn notifications on and off per entity.

AA. The DGM will offer the ability to fully operate alarm monitoring. It is possible to:
1. Center the map on entities related to the alarm.
2. Visualize the Alarm notifications on the map and access the related videos from the map.
3. Trigger and receive alarms.
4. Act on the alarm from the DGM, including acknowledgements, forwarding, and investigation.
5. Visualize that an alarm occurred in an underlying linked map.

BB. The DGM provides the following search capabilities:
1. Search and center by entity name.
2. From the Display of an entity in the USP, locate the entity on the map and offer the ability to select another one close-by.

CC. Any update of map content by an administrator is immediately and dynamically pushed to all DGM users.

DD. built-in map designer for entity positioning on the map using drag and drop. Any configuration is graphic.

EE. It is possible to edit and configure multiple map objects at once.

FF. All map design modifications is logged in an audit trail.

GG. Various actions is available within maps for execution through simple and intuitive double-click, right-click, or drag-and-drop functionality. Examples of actions available through maps includes unlocking a door and acknowledging an alarm.

HH. The DGM will offer lasso tools for:
1. Displaying entities at one location through a single action.
2. Triggering an action on all entities at one a location in a single click.
3. Editing multiple entities at one location simultaneously.

II. The DGM provides the ability to search within the map by entity name.

JJ. The Contractor provides licenses for each entity that is required to be shown on the graphical maps.

2.36 EXISTING USP AUDIT AND USER ACTIVITY TRAILS (LOGS)

A. The USP supports the generation of audit trails. Audit trails consists of logs of operator/administrator additions, deletions, and modifications.

B. Audit trails is generated as reports. They is able to track changes made within specific time periods. Querying on specific users, changes, affected entities, and time periods will also be possible.

C. For entity configuration changes, the audit trail report includes detailed information of the value before and after the changes.

D. The USP supports the generation of user activity trails. User activity trails consists of logs of operator activity on the USP such as login, camera viewed, ALPR event viewed, badge printing, video export, and more.

E. The ACS supports the following actions on an audit and activity trail report: print report and export report to a PDF/ Microsoft Excel/CSV file.

2.37 EXISTING USP INCIDENT REPORTS

A. Incident reports will allow the security operator to create reports on incidents that occurred during a shift. Both video-related and access control-related incident reports is supported.

B. The operator is able to create standalone incident reports or incident reports tied to alarms.

C. The operator is able to link multiple video sequences to an incident, access them in an incident report, and change the date or time of the sequences later on.

D. It is possible to create a list of Incident categories, tag a category to an incident, and filter the search with the category as a parameter.

E. Incident reports will allow the creation of a custom form on which to input information on an incident.

F. Incident reports will allow entities, events, and alarms to be added to support at the report’s conclusions.

PART 3 - EXECUTION

3.1 WARRANTY

A. The product will perform in all material respects in accordance with the accompanying user manual, and the media on which the Software Product resides will be free from defects in materials and workmanship under normal use. Software defects are

covered through Service Releases and Cumulative Updates which are available for a period of 1 year from the date of the software purchase.

B. Extended warranty, up to 5 years, is available through the purchase of the Genetec Advantage support service which includes the following additional services over the standard warranty:
   1. Access to phone support and online chat for technical assistance
   2. Online case management
   3. Online system availability monitor
   4. Access to Major and Minor Release Upgrades

3.2 DEPLOYMENT SERVICES AND SYSTEM COMMISSIONING

A. General Requirements:
   1. The contractor will engage the services of the USP vendor to assist in the management of the deployment of the USP at the end-user site on projects that involve:
      a. Multiple contractors or subcontractors that will be responsible for deploying the USP at multiple client sites in different geographical regions.
      b. Complex enterprise installations involving advanced functionality (for example The Federation feature, failover, plugins) and/or multiple systems (for example access control, video, ALPR) and/or third party integrations.
      c. Extensive use of customized solutions/plugins developed by the vendor that will be integrated into the USP.
   2. The USP vendor services includes Deployment Management and System Configuration and Commissioning.

B. Deployment Management Service:
   1. The Deployment Management service from the vendor includes a Project Manager acting as the single point of contact for all communications between the contractor and the vendor organization and who will be responsible for:
      a. Conducting a Risk Assessment of the impact of potential risk factors on the operation of the vendor's USP.
      b. Providing a project plan for the deployment of the vendor's USP.
      c. Managing the development and deployment of the custom solution components that will be integrated into the vendor's USP (if applicable).
      d. Providing a scope of work detailing the services to be provided by the vendor to assist in the deployment of the vendor’s USP.
      e. Coordinating and scheduling the vendor field services with the contractor to assist with the deployment of the vendor’s USP.
      f. Providing regular project status updates to the contractor regarding the development of custom solutions (if applicable) and the deployment of the vendor’s USP.

C. Solution Architect Service:
   1. The Solution Architect service from the vendor includes a Solutions Architect Engineer acting as a single technical point of contact throughout the deployment of the USP, and who will be responsible for:

a. Assisting the contractor/subcontractor with the design and architecture of the vendor's USP.
b. Conducting technical consultation activities that may include fit/gap analysis, system design reviews, device compatibility assessments, functional and technical design reviews, as well as performance reviews of the vendor's USP.
c. Conducting a system assessment and ensuring best practices of the vendor's USP are followed.
d. Providing upgrade and migration strategy for the vendor's USP where applicable.
e. Providing documentation regarding the system architecture, system design, hardware specifications and compatibility requirements, camera bandwidth calculations, and best practices as they relate to the vendor's USP.

D. System Configuration and Commissioning Service:
1. The System Configuration and Commissioning service from the vendor includes a Field Engineer who will be responsible for:
a. Assisting the contractor's or subcontractor's onsite/remote technicians with the configuration and commissioning of the vendor's USP at the client site.
b. Conducting a test of the USP following the deployment of the system using real-world operator scenarios to ensure optimal system performance.
c. Providing the contractor with a Service Report detailing the tasks completed during the deployment of the USP at the client site, as well as any recommendations for improving the performance of the USP that must be implemented by the contractor.
d. Providing a knowledge transfer of the vendor's USP to the contractor following the deployment of the USP at the client site.

3.3 MANUFACTURER END USER OPERATOR TRAINING

A. The contractor will engage the services of the USP vendor to assist in the end user training of the USP at the end-user sit. Training is no less than 8 hours for up to 20 people. Contractor will provide video recording of operator training, and provided it to the agency for future training of staff.

END OF SECTION

SECTION 28 21 00

SURVEILLANCE CAMERAS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. IP security cameras.

B. Accessory products.

1.2 RELATED SECTIONS

A. Division 26 - Electrical.

1.3 REFERENCES

A. Code of Federal Regulations (CFR).

B. Institute of Electrical and Electronics Engineers (IEEE):
1. 802.3 Ethernet Standards.

C. International Electrotechnical Commission (IEC).

D. International Organization for Standardization (ISO):
1. ISO / IEC 10918 - Information technology - Digital compression and coding of continuous-tone still images: Requirements and guidelines; JPEG.
2. ISO / IEC 14496-10 - Information Technology - Coding Of Audio-Visual Objects - Part 10: Advanced Video Coding; MPEG-4 Part 10 (ITU H.264).
3. ISO / IEC 23008-2 - High Efficiency Coding and Media Delivery in Heterogeneous Environments - Part 2: High Efficiency Video Coding; MPEG-H Part 2 (ITU H.265, HEVC).

E. European Standard (EN):
1. EN 50130-4 - Alarm Systems. Electromagnetic Compatibility. Product Family Standard: Immunity Requirements for Components of Fire, Intruder, Hold Up, CCTV, Access Control and Social Alarm Systems.
2. CE EN 50581 - Technical Documentation for the Assessment of Electrical and Electronic Products With Respect to the Restriction of Hazardous Substances.
3. EN 55022 Class A - Information Technology Equipment - Radio Disturbance Characteristics - Limits And Methods Of Measurement.
4. EN 61000-3-2-A2 - Electromagnetic Compatibility (EMC) - Part 3-2: Limits - Limits for Harmonic Current Emissions (Equipment Input Current: 16 A per phase).

5. EN 61000-3-3 - Electromagnetic Compatibility (EMC) - Part 3-3: Limits - Limitation of Voltage Changes, Voltage Fluctuations and Flicker In Public Low-Voltage Supply Systems, For Equipment With Rated Current less than or equal to 16 A Per Phase And Not Subject To Conditional Connection.

F. European Union Safety Standards (CE).

G. Federal Communications Commission (FCC):
1. FCC Rules and Regulation of Title 47 of CFR Part 15 Subpart B Class A.

H. Open Network Video Interface Forum (ONVIF):
1. ONVIF - Profiles S Specification.

I. Underwriters Laboratories (UL):
1. UL listed.

J. United States Military Standard (MIL-STD):
1. MIL-STD-810F - Environmental Engineering Considerations and Laboratory Tests.

1.4 DEFINITIONS

A. Abbreviations:
1. ARP - Address Resolution Protocol.
2. DHCP - Dynamic Host Configuration Protocol.
3. DNR - Digital Noise Reduction.
4. DDNS - Dynamic Domain Name Server.
5. fps - frames per second.
6. GUI - Graphical User Interface.
7. HDD - Hard Disk Drive.
8. HTTP - Hypertext Transfer Protocol.
9. ICMP - Internet Control Message Protocol.
10. IGMP - Internet Group Management Protocol
11. IP - Internet Protocol.
12. iSCSI - Internet Small Computer System Interface.
13. JBOD - Just a Bunch of Disks.
14. JPEG - Joint Photographic Experts Group.
15. MJPEG - Motion JPEG.
16. MP - Megapixel.
17. MPEG - Moving Pictures Experts Group.
18. NAS - Network Attached Storage.
19. NTP - Network Time Protocol.
20. POS - Point of Sale.
21. PPPoE - Pont to Point Protocol over Ethernet.
22. RAID - Redundant Array of Independent Disks (Drives).
23. RTP - Real-Time Transport Protocol.
24. RTCP - Real-Time Control Protocol.
25. RTSP - Real-Time Streaming Protocol.
26. SMTP - Simple Mail Transfer Protocol.

27. SNMP - Simple Network Management Protocol.
28. SSL - Secure Sockets Layer.
29. TCP - Transmission Control Protocol.
30. UDP - User Datagram Protocol.
31. UPnP - Universal Plug and Play.
32. VMS - Video Management System.
33. PoS - Point of Sales.
34. VA - Video Analytics.
35. PnP - Plug and Play.
36. ARB - Auto Recovery Backup.
37. NVR - Network Video Recorder.
38. RAID - Redundant Array of Independent Disks.

B. Definitions:
1. JBOD: A collection of hard disks that have not been configured to act as a redundant array of independent disks (RAID) array.
2. GOV (Group of Video object planes): A set of video frames for H.264 and H.265 compression, indicating a collection of frames from the initial I-Frame (key frame) to the next I-Frame. GOV consists of 2 kinds of frames: I-Frame and P-Frame.
3. Dynamic GOV: Dynamic assignment of GOV length based on the complexity of the scene to efficiently manage bitrate of the video stream and reduce the storage required.
4. Dynamic fps: Dynamic assignment of frames per second based on the complexity of the scene to efficiently manage bitrate of the video stream and reduce the storage required.
5. ARB (Auto Recovery Backup): Automatic backup mechanism that enables cameras to store videos on to SD card during failures and stream it to the storage device after recovery.
6. Failover: A feature that automatically switches to a redundant or standby device upon failure or unexpected shutdown of an active device.

1.5 SUBMITTALS

A. Submit under provisions of Section 01 30 00 - Administrative Requirements.

B. Product Data: Manufacturer's data sheets on each product to be used, including:
1. Manufacturer's printed or electronic data sheets.
2. Manufacturer's installation and operation manuals.
3. Warranty documentation.

C. Shop Drawings: Include details of construction, interface of equipment, and relationship with adjacent construction.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Minimum 5 year experience manufacturing similar products.

B. System Integrator shall provide the following as part of the System Solution:
   1. Complete product and technical data specification sheets that include all material and equipment and shall be available freely online.
   2. List of all equipment with part numbers, manufacturer, firmware, and assigned IP addresses.
   3. Locations and details for all components to be installed under this scope of work.
   4. Placement Diagram showing the proposed location of all system hardware devices.
   5. System Calculation of all network bandwidth and storage requirements for System Servers to ensure proper planning of computing and networking infrastructure.

C. Installer Qualifications: Minimum 2-year experience installing similar products. Installers shall be trained and authorized by the Manufacturer to install, integrate, test, and commission the system.

1.7 PRE-INSTALLATION MEETINGS

A. Convene minimum one week prior to starting work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store products in manufacturer's unopened packaging bearing the brand name and manufacturer's identification until ready for installation.

B. Handling: Handle materials to avoid damage.

1.9 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's recommended limits.

1.10 SEQUENCING

A. Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress.

1.11 WARRANTY

A. The security system VMS software and labor furnished by the System Integrator including wiring, software, hardware and third party products shall be fully warranted for parts, materials and labor for a minimum of 1 year from date of the final acceptance of the Video Surveillance System.

B. Manufacturer shall provide a limited 3 year warranty for the product to be free of defects in material and workmanship.

C. Software Licensing and Warranty:
1. Software licensing should be on a per device basis (e.g. 1 x license for 1 IP Camera or I/O device) with no base license for additional features or capabilities.
2. The VMS Software should be completely free for live streaming or playback of offline media files (images, videos).
3. Lifetime software upgrades shall be provided by the Manufacturer without cost and without the need for an annual maintenance agreement.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer:
1. Hanwha Techwin – CSI Standardized product

2.2 IP SECURITY CAMERAS

A. 5 MP Fisheyes:
1. Video Compression and Transmission: Cameras to have the following properties relating to video signals they produce.
a. Compression: H.265, H.264 and MJPEG. Each derived from a dedicated encoder and capable of being streamed independently and simultaneously.
1) H.265 and H.264: Maximum of 30 fps at all resolutions
2) MJPEG: Maximum of 15 fps
b. Video Stream Profiles: Able to configure 10 independent profiles with differing encoding, quality, frame rate, resolution, and bit rate settings.
c. Resolution Selections: Able to configure various selections in four view modes.
1) Original View: 2048 x 2048, 1280 x 1280, 1080 x 1080, 960 x 960, 768 x 768, 720 x 720, 640 x 640, and 480 x 480.
2) Single Panorama: 2048 x 512, 1920 x 480, 1280 x 320, 640 x 160, and 704 x 176.
3) Double Panorama: 2048 x 1024, 1920 x 960, 1280 x 640, 640 x 320, and 704 x 352.
4) Quad View: 2048 x 1536, 1600 x 1200, 1280 x 960, 1024 x 768, 800 x 600, 640 x 480, and 704 x 576.
d. Video Streams: 10 independent stream types using unicast protocol.
1) Multicast and unicast video streaming.
e. DDNS Configurable: At no additional cost by manufacturer.
2. Camera Physical and Performance Properties:
a. Wi-Fi interface: Stream video to a smart phone for installation purposes.
1) Wi-Fi dongle is required for Wi-Fi connection.
b. Produce clear images in highly contrast scenes with multi-exposure wide dynamic range up to 120 dB.

c. Day and Night Operation:
   1) Automated, manual, scheduled, or externally triggered with infrared cut filter.
   2) Images available in color or black and white.
   3) Low Light Level Operation: Color Mode: 0.1 lux (F1.6). Black and White Mode: 0 (IR LED on).
d. Digital Noise Reduction: 2D and 3D technology.
e. Privacy Masking Regions: 32 Configurable regions utilizing a polygon.
f. Defog Feature: Remove fogginess of scene. Triggered automatically from fog detection event.

3. Intelligence and Analytics: A suite of integral intelligent operations and analytic functions to include:
   a. Motion Detection:
      1) Eight definable detection areas with eight point polygonal zones, minimum and maximum object size.
      2) Hand-Over to PTZ Cameras. Calls a preset of PTZ camera when motion event is triggered.
   b. Logical Events Detection from Camera Video Input:
      1) Tampering.
      2) Loitering.
      3) Directional detection.
      4) Virtual line.
      5) Enter/Exit.
      6) (Dis)Appear.
      7) Audio detection.
   c. Logical Events Detection from Camera Audio Input:
      1) Scream.
      2) Gunshot.
      3) Explosion.
      4) Crashing glass.
   d. Business Intelligence:
      1) People Counting.
      2) Heatmap.
      3) Queue Management.
4. Interoperability: ONVIF Profile S and G compliant. Allow users to install third party applications from manufacturer's partners through Open Platform. List of available applications and partners to be available from manufacturer's homepage.
5. Camera Characteristics:
   a. Built-in web server, accessed via standard browsers including MS Internet Explorer, Firefox, Chrome and Safari.
   b. Streaming to multiple smart phones with DDNS provided freely from the manufacturer.
   c. Micro SD/SDHC/SDXC memory card with configurable pre-alarm and post-alarm recording intervals.
   d. NAS recording option with configurable pre-alarm and post-alarm recording intervals.
   e. Alarms and Notifications:
      1) Triggers:

f. Alarm input.
g. Motion detection.
h. Video and audio analytics.
i. Network disconnection.
1) Available Notification Means Upon Trigger:
j. File upload via FTP and e-mail.
k. Notification via e-mail.
l. Record to local storage (SD / SDHC / SDXC) or NAS.
m. External output.
n. Pixel counter available in the web viewer.
o. PoE capable.

B. 5 MP Indoor Domes:
1. Video Compression and Transmission: Cameras to have the following properties relating to video signals they produce.
a. Compression: H.265, H.264 and MJPEG. Each derived from a dedicated encoder and capable of being streamed independently and simultaneously.
1) H.265 and H.264: Maximum of 30 fps at all resolutions
2) MJPEG: Maximum of 30 fps
b. Video Stream Profiles: Able to configure 10 independent profiles with differing encoding, quality, frame rate, resolution, and bit rate settings.
c. Resolution Selections: Able to configure various selections.
1) Aspect Ratio of 16:9: 2560 x 1440, 1920 x 1080, 1280 x 720, 800 x 448, and 640 x 360.
2) Aspect Ratio of 4:3: 2560 x 1920, 1600 x 1200, 1280 x 960, 1024 x 768, 800 x 600, 640 x 480, and 320 x 240.
3) Aspect Ratio of 5:4: 1280 x 1024 and 720 x 576.
4) Aspect Ratio of 3:2: 720 x 480.
d. Video Streams: 10 independent stream types using unicast protocol.
1) Multicast and unicast video streaming.
e. DDNS Configurable: At no additional cost by manufacturer.
f. Smart Codec: Dynamic GOV, and Dynamic fps to efficiently manage bitrate of video stream.
2. Camera Physical and Performance Properties:
a. Impact Protection: IK08 rated.
b. True Day/Night Operation: Removable IR cut filter.
1) Low Light Level Operation:
a) Color Mode: 0.07 lux at F1.3
b) Color Mode: 0.16 lux at F1.6
c) Black and White Mode: 0 lux with IR LED on.
c. Digital Noise Reduction: 2D and 3D technology.
d. Integral IR Illumination: Effective visibility of 98.43 ft (30 m) at 0 Lux when activated in Black and White mode.
e. Configurable privacy masking regions utilizing a 4 point polygon.
3. Intelligence and Analytics: A suite of integral intelligent operations and analytic functions to include:
a. Motion Detection: Eight definable detection areas with 8 point polygonal zones, minimum and maximum object size.
b. Logical Events Detection from Camera Video Input:

1) Tampering (scene change).
2) Defocus detection.
3) Fog detection.
4) Motion detection with metadata.
5) Face detection.
6) Virtual Area Based Event:
    d) Intrusion.
    e) Enter or exit.
    f) Appear or disappear.
    g) Loitering.
7) Virtual Line Based Event:
    h) Directional detection.
    i) Crossing.

c. Logical Events Detection from Camera Audio Input:
1) Scream.
2) Gunshot
3) Explosion
4) Crashing glass.

4. Interoperability: ONVIF Profile S and G compliant.
5. Camera Characteristics:
a. Built-in web server, accessed via standard browsers including MS Internet Explorer, Firefox, Chrome and Safari.
b. Dual edge recording slot like Micro SD/SDHC/SDXC memory card with configurable pre-alarm and post-alarm recording intervals.
c. NAS recording option with configurable pre-alarm and post-alarm recording intervals.
d. Bi-directional audio.
e. Alarms and Notifications:
1) Triggers:
    a) Alarm input.
    b) Motion detection.
    c) Tampering detection.
    d) Defocus detection.
    e) Fog detection.
    f) Face detection.
    g) Audio detection.
    h) Video and audio analytics.
    i) Network disconnect.
2) Available Notification Means Upon Trigger:
    a) File upload via FTP and e-mail.
    b) Notification via e-mail.
    c) Record to local storage (SD card) or NAS.
    d) External output.
    e) Move to DPTZ preset.
f. Pixel counter available in the web viewer.
g. PoE capable.

C. 5 MP Indoor Dome Flush Mount:
1. Video Compression and Transmission: Cameras to have the following properties

relating to video signals they produce.

a. Compression: H.265, H.264 and MJPEG. Each derived from a dedicated encoder and capable of being streamed independently and simultaneously.
   1) H.265 and H.264: Maximum of 30 fps at all resolutions
   2) MJPEG: Maximum of 30 fps
b. Video Stream Profiles: Able to configure 10 independent profiles with differing encoding, quality, frame rate, resolution, and bit rate settings.
c. Resolution Selections: Able to configure various selections.
   1) 2560 x 1920, 2560 x 1440, 1920 x 1080, 1600 x 1200, 1280 x 1024, 1280 x 960, 1280 x 720, 1024 x 768, 800 x 600, 800 x 448, 720 x 576, 720 x 480, 640 x 480, 640 x 360, and 320 x 240.
d. Video Streams: 10 independent stream types using unicast protocol.
   1) Multicast and unicast video streaming.
e. DDNS Configurable: At no additional cost by manufacturer.

2. Camera Physical and Performance Properties:
   a. Wi-Fi Interface: Stream video to smart phones for installation purposes.
   b. Produce clear images in highly contrast scenes with multi-exposure wide dynamic range.
   c. Electrical day/night operation with scheduling and options for external devices.
      1) Low light level operation to 0.16 lux at F1.6 (1/30 sec) in color mode and black and white mode.
   d. Digital Noise Reduction: 2D and 3D technology.
   e. Privacy Masking Regions: 32 Configurable regions utilizing a polygon.
   f. Cabling: RJ45 to reduce installation effort.
      1) Audio Input: Built-in MIC and alarms received and sent through Ethernet cable.
      2) Power: Supplied by PoE and CVBS often required for installers to be replaced by aforementioned Wi-Fi interface.
   g. Magnetic Dome Cover: Easy physical installation requiring no screw on camera body except temper screw, available optionally.
   h. Design: Compact with minimum exposure of camera body and minimum effect on design of surroundings. Dome cover is the only part of whole camera body exposed.
      1) Color: White

3. Intelligence and Analytics: A suite of integral intelligent operations and analytic functions to include:
   a. Motion Detection:
      1) Eight definable detection areas with eight point polygonal zones, minimum and maximum object size.
      2) Hand-Over to PTZ Cameras. Calls a preset of PTZ camera when motion event is triggered.
   b. Logical Events Detection from Camera Video Input:
      1) Tampering.
      2) Loitering.
      3) Directional detection.
      4) Defocus detection.
      5) Fog detection.
      6) Virtual line.

7) Enter and exit.
8) (Dis)Appear.
9) Face detection.
10) Motion detection.
11) Digital auto tracking.
12) Heat map.
13) People counting.
14) Queue management.

c. Logical Events Detection from Camera Audio Input:
1) Scream
2) Gunshot
3) Explosion
4) Crashing glass

4. Interoperability: ONVIF Profile S and G compliant.
5. Camera Characteristics:
a. Built-in web server, accessed via standard browsers including MS Internet Explorer, Firefox, Chrome and Safari.
b. Streaming to multiple smart phones with DDNS provided freely from the manufacturer.
c. Micro SD/SDHC/SDXC memory card with configurable pre-alarm and post-alarm recording intervals.
d. NAS recording option with configurable pre-alarm and post-alarm recording intervals.
e. Alarms and Notifications:
1) Alarm Notification Triggers:
a) Motion detection.
b) Video analytics.
c) Network disconnection.
2) Available notification means upon trigger:
a) File upload via FTP and e-mail.
b) Notification via e-mail.
c) Record to local storage (SD card) or NAS storage.
d) Move to DPTZ preset.
f. Pixel Counter available in the web viewer.
g. PoE capable.

D. 5 MP Outdoor Domes:
1. Video Compression and Transmission: Cameras to have the following properties relating to video signals they produce.
a. Compression: H.265, H.264 and MJPEG. Each derived from a dedicated encoder and capable of being streamed independently and simultaneously.
1) H.265 and H.264: Maximum of 30 fps at all resolutions
2) MJPEG: Maximum of 30 fps
3) Maximum frame rates are available at selected resolutions:
a) H.265 and H.264: 30 fps is available at all resolutions.
b. Video Stream Profiles: Able to configure 10 independent profiles with differing encoding, quality, frame rate, resolution, and bit rate settings.
c. Resolution Selections: Able to configure various selections.
1) Aspect Ratio of 16:9: 2560 x 1440, 1920 x 1080, 1280 x 720, 800 x 448,

and 640 x 360.
2) Aspect Ratio of 4:3: 2560 x 1920, 1600 x 1200, 1280 x 960, 1024 x 768, 800 x 600, 640 x 480, and 320 x 240.
3) Aspect Ratio of 5:4: 1280 x 1024 and 720 x 576.
4) Aspect Ratio of 3:2: 720 x 480.

d. Video Streams: 10 independent stream types using unicast protocol.
1) Multicast and unicast video streaming.

e. DDNS Configurable: At no additional cost by manufacturer.
f. Smart Codec: Dynamic GOV, and Dynamic fps to efficiently manage bitrate of video stream.

2. Camera Physical and Performance Properties:
a. Dustproof, waterproof, and IP67 rated.
b. Impact Protection: IK10 rated.
c. True Day/Night Operation: Removable IR cut filter.
1) Low Light Level Operation:
a) Color Mode: 0.07 lux at F1.3.
b) Color Mode: 0.16 lux at F1.6.
c) Black and White Mode: 0 lux with IR LED on.

d. Digital Noise Reduction: 2D and 3D technology.
e. Configurable privacy masking regions utilizing a 4 point polygon

3. Intelligence and Analytics: A suite of integral intelligent operations and analytic functions to include:
a. Motion Detection: Eight definable detection areas with 8 point polygonal zones, minimum and maximum object size.
b. Logical Events Detection from Camera Video Input:
1) Tampering (scene change).
2) Defocus detection.
3) Fog detection.
4) Motion detection with metadata.
5) Face detection.
6) Virtual Area Based Event:
a) Intrusion.
b) Enter or exit.
c) Appear or disappear.
d) Loitering.
7) Virtual Line Based Event:
a) Directional detection.
b) Crossing.

c. Logical Events Detection from Camera Audio Input:
1) Scream.
2) Gunshot.
3) Explosion.
4) Crashing glass.

4. Interoperability: ONVIF Profile S and G compliant.
5. Camera Characteristics:
a. Built-in web server, accessed via standard browsers including MS Internet Explorer, Firefox, Chrome and Safari.
b. Dual edge recording slot like Micro SD/SDHC/SDXC memory card with configurable pre-alarm and post-alarm recording intervals.

c. NAS recording option with configurable pre-alarm and post-alarm recording intervals.
d. Bi-directional audio.
e. Alarms and Notifications:
    1) Triggers:
        a) Alarm input.
        b) Motion detection.
        c) Tampering detection.
        d) Defocus detection.
        e) Fog detection.
        f) Face detection.
        g) Audio detection.
        h) Video and audio analytics.
        i) Network disconnect.
    2) Available Notification Means Upon Trigger:
        a) File upload via FTP and e-mail.
        b) Notification via e-mail.
        c) Record to local storage (SD card) or NAS.
        d) External output.
        e) Move to DPTZ preset.
f. Pixel counter available in the web viewer.
g. PoE capable.

E. 5 MP Bullets:
1. Video Compression and Transmission: Cameras to have the following properties relating to video signals they produce.
    a. Compression: H.265, H.264 and MJPEG. Each derived from a dedicated encoder and capable of being streamed independently and simultaneously.
        1) H.265 and H.264: Maximum of 30 fps at all resolutions
        2) MJPEG: Maximum of 30 fps
        3) Maximum frame rates are available at selected resolutions:
            a) H.265 and H.264: 30 fps is available at all resolutions.
            b) MJPEG: 30 fps is available
    b. Video Stream Profiles: Able to configure 10 independent profiles with differing encoding, quality, frame rate, resolution, and bit rate settings.
    c. Resolution Selections: Able to configure various selections.
        1) Aspect Ratio of 16:9: 2560 x 1440, 1920 x 1080, 1280 x 720, 800 x 448, and 640 x 360.
        2) Aspect Ratio of 4:3: 2560 x 1920, 1600 x 1200, 1280 x 960, 1024 x 768, 800 x 600, 640 x 480, and 320 x 240.
        3) Aspect Ratio of 5:4: 1280 x 1024 and 720 x 576.
        4) Aspect Ratio of 3:2: 720 x 480.
    d. Video Streams: 10 independent stream types using unicast protocol.
        1) Multicast and unicast video streaming.
    e. DDNS Configurable: At no additional cost by manufacturer.
    f. Smart Codec: Dynamic GOV, and Dynamic fps to efficiently manage bitrate of video stream.
2. Camera Physical and Performance Properties:
    a. Dustproof, waterproof, and IP67 rated.

b. Impact Protection: IK10 rated.
c. True Day/Night Operation: Removable IR cut filter.
    1) Low Light Level Operation
        a) Color Mode: 0.07 lux at F1.2.
        b) Color Mode: 0.16 lux at F1.
        c) Black and White Mode: 0 lux with IR LED on
d. Digital Noise Reduction: 2D and 3D technology.
e. Configurable privacy masking regions utilizing a 4 point polygon
f. Video display on smart phone (iPhone, Android) to adjust viewing angle, rotation and focus.

3. Intelligence and Analytics: A suite of integral intelligent operations and analytic functions to include:
    a. Motion Detection: Eight definable detection areas with 8 point polygonal zones, minimum and maximum object size.
    b. Logical Events Detection from Camera Video Input:
        1) Tampering (scene change).
        2) Defocus detection.
        3) Fog detection.
        4) Motion detection with metadata.
        5) Face detection.
        6) Virtual Area Based Event:
            a) Intrusion.
            b) Enter or exit.
            c) Appear or disappear.
            d) Loitering.
        7) Virtual Line Based Event:
            a) Directional detection.
            b) Crossing.
    c. Logical Events Detection from Camera Audio Input:
        1) Scream.
        2) Gunshot.
        3) Explosion.
        4) Crashing glass.
4. Interoperability: ONVIF Profile S and G compliant.
5. Camera Characteristics:
    a. Built-in web server, accessed via standard browsers including MS Internet Explorer, Firefox, Chrome and Safari.
    b. Dual edge recording slot like Micro SD/SDHC/SDXC memory card with configurable pre-alarm and post-alarm recording intervals.
    c. NAS recording option with configurable pre-alarm and post-alarm recording intervals.
    d. Bi-directional audio.
    e. Alarms and Notifications:
        1) Triggers:
            a) Alarm input.
            b) Motion detection.
            c) Tampering detection.
            d) Defocus detection.
            e) Fog detection.

a) Face detection.
b) Audio detection.
c) Video and audio analytics.
d) Network disconnect.

2) Available Notification Means Upon Trigger:
a) File upload via FTP and e-mail.
b) Notification via e-mail.
c) Record to local storage (SD card) or NAS.
d) External output.
e) Move to DPTZ preset.

f. Pixel counter available in the web viewer.
g. PoE capable.

2.3 ACCESSORLES

A. Accessory Products: Provide the following, as applicable to the system selected and as scheduled on the Drawings.
1. Backbox mounting.

PART 3 - EXECUTION

3.1 PREPARATION

A. System Integrator: Confirm the solution proposal planning and design with the installing contractor.

B. The network design and configuration to be verified for compatibility and performance with the input/output devices.

C. Network Configuration: Tested and qualified by Contractor prior to remote device installation.

D. Equipment to be tested and configured in accordance with instructions provided by the System Integrator prior to installation.

E. All firmware found in products to be the latest and most up-to-date provided by the manufacturer, or of a version as specified by the provider of the Video Management Application (VMA).

F. All equipment requiring users to log on using a password to be configured with user/site-specific password/passwords. No system/product default passwords shall be allowed.

G. Confirm hardware will be stored in an environment where temperature and humidity are in the range specified by the Manufacturer.

3.2 INSTALLATION

A. Install products per manufacturer's recommendations and approved submittals.
   1. Comply with documentation provided by the System Integrator to insure all steps have been taken to provide a reliable, easy-to-operate system.

B. Contractor personnel must comply with all applicable state and local licensing requirements.

C. Before permanent installation of the system, the Contractor will test the system in conditions simulating the final installed environment witnessed by the System Integrator. Adjust as required until proper operation is achieved.

END OF SECTION

SECTION 28 23 00

EXISTING VIDEO MANAGEMENT SYSTEM

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 281300 – Electronic Access Control System

1.2 DEFINITIONS

A. ACS – Access Control System

B. CSA – Client Software Application

C. DGM – Dynamic Graphical Maps

D. DVS – Digital Video Server

E. ALPR – Automatic License Plate Recognition

F. SDK – Software Development Kit

G. GLM – Genetec Lifecycle Management

H. SSM – Server Software Module

I. UI – User Interface

J. USP – Unified Security Platform

K. USW – Unified Web Client

L. VMS – Video Management System

1.3 QUALIFICATIONS

A. The system programmer will have attended manufacturer training and obtained certification in Genetec Security Center - Omnicast™ Technical Certification.

B. Optionally, the system programmer will have attended manufacturer training and obtained certification in Genetec Security Center - Enterprise Technical Certification.

C. The system programmer will be a Genetec certified partner with the following level of qualification:

1. Unified Elite Reseller

D. The system programmer will submit proof of certification.

PART 2 - PRODUCTS

2.1 EXISTING VMS GENERAL REQUIREMENTS

A. The existing VMS is based on a true open architecture that allows the use of non-proprietary workstation and server hardware, non-proprietary network infrastructure, and non-proprietary storage.

B. The existing VMS offers a complete and scalable video surveillance solution that allows cameras to be added on a unit-by-unit basis.

C. The existing VMS will interface with analog-to-digital video encoders and IP cameras and with digital-to-analog video decoders, hereafter referred to as digital video servers (DVS). The VMS will support DVS from various manufacturers.

D. The existing VMS will integrate DVS using the DVS native SDK or using the following industry standards to interface to the DVS:
1. ONVIF

E. All video streams supplied from analog cameras or IP cameras are digitally encoded in H.265, H.264, MPEG-4, MPEG-2, MJPEG, MxPEG, Wavelet, or JPEG2000 compression formats and recorded simultaneously in real time.

F. All audio streams supplied from IP video servers are digitally encoded in g711 (u-law), g721, g723, or AAC compression formats and recorded simultaneously in real time.

G. Each camera’s bit rate, frame rate, and resolution is set independently from other cameras in the system and altering these settings will not affect the recording and display settings of other cameras.

H. The existing VMS are able to use multiple CCTV keyboards to operate the entire set of cameras throughout the system, including brands of cameras from various manufacturers and including their PTZ functionalities (i.e. Pelco keyboard controls Panasonic dome or vice-versa).

I. The existing VMS are able to retrieve and set the current position of PTZ cameras using XYZ coordinates.

J. The existing VMS supports PTZ camera protocols from multiple manufacturers, including analog and IP protocols.

K. The VMS arbitrates the user conflict on PTZ usage based on user levels per camera.

L. The existing VMS supports the following list of CCTV keyboard protocols:

1. American Dynamics 2078 ASCII, and American Dynamics 2088 ASCII
2. Bosch Autodome, Bosch Intuikey
3. DVTel
4. GE ImpactNet
5. Panasonic, Pelco ASCII, Pelco KBD-300, Pelco 9760, and Pelco P.
6. Radionics
7. Hanwha Techwin SSC-100, SPC-600, SPC-2010, SPC-6000, and SPC-7000.
8. Videoalarm
9. Sony RM-NS1000
10. Panasonic WV-CU161C

M. The existing VMS supports the following list of joysticks and control keyboards:
1. Axis 295.
2. Axis T8310, T8311, T8312, T8313 Video Surveillance Control Board.
3. Panasonic WV-CU950 Ethernet keyboard.
4. Any USB joystick detected as a Windows Game Controller.

N. The existing VMS allowS for the configuration of a time zone for each camera connected to a DVS. For playback review, users has the ability to search for video based on the following options:
1. Local time of the camera
2. Local time of the SSM
3. Local time of user's workstation
4. GMT Time
5. Other time zone

O. The existing SSM does not limit the actual storage capacity configured per server.

P. Manufacturer:
1. Genetec Security Center:
a. Omnicast Enterprise

2.2 CYBER SECURITY REQUIREMENTS

A. The existing USP is an IP enabled solution. All communication between the SSM and CSA based on standard TCP/IP protocol and uses TLS encryption with digital certificates to secure the communication channel.

B. The existing USP supports user authentication with claims-based authentication using external providers. External providers includes:
1. ADFS (Active Directory Federation Services)

C. The USP limits the IP ports in use and provides the Administrator with the ability to configure these ports.

D. The existing VMS supports only secured media stream requests, unless explicitly configured otherwise. Secured media stream requests are secured with strong certificate based authentication leveraging RTSPS (RTSP over TLS). Client authentication for media stream requests is claims-based and may use a limited

lifetime security token.

E. The existing VMS offers the ability to encrypt the media stream, including video, audio, and metadata with authenticated encryption. Media stream encryption are done at rest and in transit and be a certificate based AES 128-bits encryption. The VMS will:
   1. Allow encryption to be set on a per camera basis for all or some of the cameras.
   2. Provide up to 20 different certificates for different groups of CSA or users who have been granted access to decrypted streams.
   3. Not decrease the recording performance by more than 50% when encryption is enabled.
   4. Use Secure RTP (SRTP) to encrypt the payload of a media stream in transit and allow multicast and unicast of the encrypted stream.
   5. Use a random encryption key and change periodically.
   6. Allow encrypted streams to be exported.

F. The existing VMS supports end to end encrypted streams with cameras supporting Secure RTP (SRTP) both in unicast and multicast from the camera.

G. The existing USP supports encryption for all communications with its databases.

H. The existing USP provides in its main user interface a visual list showing the state of all configuration items relating to the cyber security hardening of the features of the system.

I. The existing USP provides recommendations relating to the passwords used to access the hardware units in the system. The recommendation displays if the passwords used on the units are weak, average, strong, or very strong.

J. The existing USP provides recommendations relating to the firmware of the hardware units enrolled in the system. Recommendations displays if the firmware is up to date, out of date, or if it has known security vulnerabilities.

2.3 EXISTING ARCHIVING

A. The Archiver (role) will use an event and timestamp database for the advanced search of audio/video archives. This database uses Microsoft SQL.

B. The Archiver protects archived audio/video files and the system database against network access and non-administrative user access.

C. The Archiver digitally signs a recorded video using 248-bit RSA public/private key cryptography.

D. The Archiver offers a plug and play type hardware discovery service with the following functionalities:
   1. Automatically discover DVS units as they are attached to the network.
   2. Discover DVS units on different network segments, including the Internet, and across routers with or without network address translation (NAT) capabilities.

E. The Archiver has the capacity to configure the key frame interval (I-frame) in seconds or number of frames.

F. The Archiver provides a pre-alarm and post-alarm recording option that can be set between one second and 5 minutes on a per camera basis.

G. The Archiver provides the functionality of storing of video and audio streams based on triggering events, such as:
   1. Digital motion detection
   2. Digital input activation
   3. Macros
   4. Through SDK application recording

H. The Archiver performs video motion detection on each individual camera based on a grid of 1320 motion detection blocks. All of the video motion detection settings are configurable on schedule. A global sensitivity threshold is available to reduce motion detection sensitivity when the video signal is noisy or when a lot of false hits are incurred. Video motion detection itself can be set into four different modes:
   1. Full Screen: All 1320 blocks on screen are activated, and a general threshold for the overall motion in the entire image can be set, and when it is reached, it can trigger recording and a motion event or a custom event.
   2. Full Screen Unit: This is the same as the Full Screen but the motion detection takes place in the DVS.
   3. Detection Zone: Six overlapping zones can be defined in the 1320 blocks on screen with each of these zones having its own threshold, and, when that threshold is reached, each one of them can trigger recording and a motion event or a custom event. Each zone triggering its own event allows for the configuration of directional motion detection events and other complex motion detection logic.
   4. Detection Zone Unit: This is the same as the Detection Zone, but the motion detection takes place in the DVS and only one zone is supported.
   5. Disabled: No motion detection is performed on this camera.

I. The Archiver are able to detect motion in video within 200 milliseconds and not only on key frames.

J. The Archiver will allow for multiple recording schedules to be assigned to a single camera. Each schedule are created with the following parameters:
   1. Recording mode:
      a. Continuous
      b. On Motion/Manual
      c. Manual
      d. Disabled
   2. Recurrence pattern:
      a. Once on specific days
      b. Specific days on a yearly basis
      c. Specific days on a monthly basis
      d. Specific days on a weekly basis
      e. Daily

K. Time coverage:
   1. All day.
   2. Specific time range(s).
   3. Daytime or nighttime based on the times of sunrise and sunset that are automatically calculated from the time of year and a geographical location. Provision are given to offset the calculated sunrise or sunset time by plus or minus 3 hours.

L. The Archiver will allow each camera (video source) to be encoded multiple times in the same or different video formats (H.265, H.264, MPEG-4, MPEG-2, MJPEG, MxPEG, Wavelet, or JPEG2000), limited only by the capabilities of each DVS.

M. Whenever multiple video streams are available from the same camera, users are free to use any one of them based on their assigned usage. The standard video stream usages are:
   1. Live
   2. Recording
   3. Remote
   4. Low resolution
   5. High resolution

N. The Archiver will allow the video quality to vary according to predefined schedules. Such schedules will have the same configuration flexibility as the recording schedules mentioned earlier. The video quality are based on, but not limited to, the following parameters:
   1. Maximum bit rate
   2. Maximum frame rate
   3. Image quality
   4. Key frame interval

O. The Archiver will have the ability to dynamically boost the quality of the "recording stream" (see previous bullet) based on specific events:
   1. When recording is started manually by a user.
   2. When recording is triggered by a macro, an alarm or detected motion.

P. The Archiver will have the capacity to communicate with the DVS using 128 bits SSL encryption.

Q. The Archiver will have the capacity to communicate with the DVS using HTTPS secure protocol.

R. The Archiver will have the capacity to receive multicast UDP streams directly from the DVS.

S. For network topologies that restrict the DVS from sending multicast UDP streams, the Archiver will redirect audio/video streams to active viewing clients on the network using multicast UDP.

T. The Archiver will have the capacity to redirect audio/video streams to active viewing clients on the network using unicast UDP or TCP.

U. The Archiver will empower the administrator with a full range of disk management options:
   1. The Archiver will allow the administrator to choose which disks to use for archiving and to set a maximum quota for each.
   2. The Archiver will allow the administrator to spread the archiving of different cameras on different disk groups (groups of disks controlled by the same controller) so that archiving could be carried out in parallel on multiple disks.
   3. The Archiver will have the capacity to move video archives to the Azure Cloud. The archives will be moved after a preset number of days.

V. The Archiver offers the following options to clean up old archives, on a camera by camera basis:
   1. After a preset number of days.
   2. Deleting oldest archives first when disks run out of space.
   3. Stop archiving when disks are full.

W. The Archiver will allow important video sequences to be protected against normal disk cleanup routines.

X. Users will have the following options when protecting a video sequence:
   1. Until a specified date
   2. For a specified number of days
   3. Indefinitely (until the protection is explicitly removed)

Y. The Archiver will allow the administrator to put a cap on the percentage of storage space occupied by protected video.

Z. The Archiver will keep a log and compile statistics on disk space usage.
   1. The statistics are available by disk group or for the whole Archiver.
   2. The statistics will show the percentage of protected video over the total used disk space.

AA. The Archiver will have the capacity to down-sample video streams for storage saving purposes. The down-sampling options available are the following:
   1. For H.264, MPEG-4, and H.265, streams the down-sampling options are: all key frames, 1 fps, 2 sec./frame, 5 sec./frame, 10 sec./frame, 15 sec./frame, 30 sec./frame, 60 sec./frame, 120 sec./frame.
   2. For MJPEG streams the down-sampling options are: 15 fps, 10 fps, 5 fps, 2 fps, 1 fps, 2 sec./frame, 5 sec./frame, 10 sec./frame, 15 sec./frame, 30 sec./frame, 60 sec./frame, 120 sec./frame.

BB. The Archiver supports DVS with edge recording capabilities and offer the following capacity:
   1. The ability to playback the video recorded on the DVS at different speeds.
   2. The ability to offload (video trickling) the video recorded on the DVS on schedule, on event, or manually to store it on the Archiver.
   3. It are possible to filter the video that is being offloaded using one or multiple of the following filters:
      a. Time interval
      b. Playback request

c. Video analytic events
d. Motion events
e. Bookmarks
f. Alarms
g. Input pin events
h. Unit offline events

CC. The Archiver are provided with proven performance and scalability figures:
1. The Archiver's performance are guaranteed during the rebuild of a disk from a raid 5 disk group. The rebuild process will not affect the recording and playback capabilities.
2. The recommended server specification from the Genetec Security Center Hardware Requirement will allow Archiver to perform up to 300 cameras or 300Mbs throughput first limit reached.

2.4 AUXILIARY ARCHIVER (SPECIFIER, ENTERPRISE ONLY, ADDITIONAL LICENSE REQUIRED)

A. The Auxiliary Archiver are used to produce redundant archives (video, events, or bookmarks) for any camera in the system, on a case by case basis.

B. The Auxiliary Archiver will have the ability to record a camera on a different schedule than the Archiver.

C. The Auxiliary Archiver will have the ability to archive any of the standard video streams for archiving. The standard video stream usages are: Live, Recording, Remote, Low Resolution, and High Resolution.

D. The Auxiliary archiver will have the capacity to move video archives to the Azure Cloud.

E. From the cloud, to playback recordings without requiring an additional transfer.

2.5 EXISTING VMS MEDIA STREAMING

A. The Media Router Role are responsible for routing video and audio streams across local and wide area networks from the source (for example DVS) to the destination (for example CSA).

B. The Media Router Role supports multiple transport protocols, such as unicast TCP, unicast UDP, and multicast UDP.

C. The Media Router supports IGMP (Internet Group Management Protocol) to establish multicast group memberships:
   1. IGMP v3, including SSM (Source-Specific Multicast) are supported.

D. The Media Router Role using Redirector Agents are responsible for redirecting a stream from a source IP endpoint to a destination IP endpoint.

E. The Redirector Agents are capable of converting a stream from and to any supported transport protocols:
   1. Multicast UDP to Unicast TCP
   2. Multicast UDP to Unicast UDP
   3. Unicast TCP to Multicast UDP
   4. Unicast UDP to Multicast UDP

F. It are possible to limit the number of concurrent live and playback video redirections for each Redirector Agent in order to better control the bandwidth across multiple sites.

G. It are possible to limit the bandwidth consumed by live and playback video from the CSA to better control the bandwidth across multiple sites. The SSM are able to prioritize video streaming to the CSA based on user level.

H. It are possible to protect the Media Router Role against hardware or software unavailability by configuring another Media Router Role to act as a hot standby server.

I. Multiple Redirector Agents are used on a large VMS installation to increase the service availability and to provide automatic load balancing.

2.6 EXISTING VMS VIDEO ARCHIVES TRANSFER CAPABILITIES

A. Archive transfer provides the ability to:
   1. Transfer video from a server to another server in the same system.
   2. Transfer video from a federated server to another server.
   3. Transfer video from camera storage to a server.

B. It are possible to program video transfers either on a recurrent schedule, or to trigger them manually or upon connection.

C. It are possible to filter the video of interest for a transfer. The video of interest are

defined with the following filters:

1. All archives when the camera was offline.
2. Alarms.
3. Playback request from the edge.
4. Video analytics events.
5. Motion events.
6. Bookmarks.
7. Input triggers.
8. Time range.

D. It are possible to define the length of video before and after the event used as a filter to determine the video of interest.

E. The USP offers an interface for displaying all video archive transfer requests. This interface will display all the current, requested and scheduled video transfer requests. It are possible to edit, trigger, and cancel video archive transfers from this interface.

2.7 EXISTING SECURITY VIDEO ANALYTICS

A. The analytics are completely unified with the Video Management System.

B. Configuration will natively be performed in the configuration interface of the Video Management System.

C. The analytics will feature dedicated configuration possibilities for the following scenarios:

1. Perimeter protection
2. Area protection
3. Direction control
4. Object detection
5. Stopped vehicle detection

D. Each of the scenarios will trigger events in the Video Management System, which correspond to their functionality.

E. Additional to these scenarios, the analytics will allow to configure custom intrusion detection and object detection scenarios as well as allow to import settings to allow maximum flexibility.

F. The analytics license will allow to configure any one of these scenarios per camera.

G. The analytics will allow at least two different detection variants:

1. Trigger an alarm if a motion pattern moves from zone A (source) through zone B into zone C (sink).
2. Trigger an alarm if a motion pattern moves anywhere inside a specified zone.

H. The analytics supports an unlimited number of detection areas.

I. The analytics feature rain-filters to filter out disturbances.

J. The analytics will feature live configuration to immediately see the effects of parameter changes in the configuration interface without prior saving new configurations.

K. The configuration of the analytics are possible on recorded video streams.

L. The analytics offers the possibility to configure object movement paths.

M. The analytics will not employ tripwires or cross-lines.

N. Areas and the scenes perspective (near and far object size) are configured on-screen using a point-and-click interface.

O. The analytics will feature filters for movement speed, distance, and direction to detect events.

P. The analytics will feature options to separately show or hide areas, area names, and detection overlays.

Q. The analytics are fully server-based, with no calculation on cameras necessary.

R. The analytics will operate with color, thermal, and infrared cameras.

S. The accuracy of the analytics are evaluated and approved by the CPNI Video Analytics Assessment Program and are listed in the CPNI Catalogue of Security Equipment (CSE).

2.8 EXISTING CAMERA INTEGRITY MONITOR

A. Description:
1. Automatically checks camera feeds to detect if cameras have been tampered with.
2. Can be used for near-real-time alerting of tampering events or as a maintenance tool.
3. Reports can be run on detected tampering events.

B. Details:
1. It are completely unified with the Video Management System.
2. It are possible to set the detection sensitivity per camera stream between low, medium, and high.
3. It are possible to choose on which servers the analytics will run.
4. The camera stream used for analytics are configurable.
5. It are possible to define how many cameras are being analyzed at the same time.
6. To utilize minimum hardware resources, it are definable how often camera streams are analyzed.
7. There are an overview over which cameras are configured to be analyzed.

2.9 EXISTING PRIVACY PROTECTOR

A. Description:
   1. Automatically obscures all movement in surveillance videos in real-time.
   2. Live privacy masking of moving objects (such as people and vehicles).
   3. Completely unified with the video management system.
   4. Native configuration in the configuration interface of the video management system.

B. Details:
   1. Certified with a valid EuroPriSe certification seal.
   2. Indoor / outdoor modes using flexible background modeling:
      a. Indoor: Learning model with up to 10 different illumination states – this allows to adapt to fast lighting changes such as lights switching on and off.
      b. Outdoor: Foreground detection based on edge detection rather than color – this allows to adapt to heavily changing lighting conditions such as clouds temporarily blocking sunlight.
   3. Detects movements using an absolute difference image, calculated by subtracting the current frame from a calculated background model.
   4. Masks movements using blocks, thus obscuring the outline of an object or person.
   5. Eight different scrambling methods: Pixelation, Colorize, and Transparency.
   6. Masking grids can be configured in a point-and-click interface.
   7. Past preview mode to see configuration changes in the configuration interface without necessity to save the configuration.
   8. Zones can be freely definable polygons with a point-and-click interface.
   9. Option to set analysis resolution to optimize performance.
   10. No calculation on the camera necessary, completely server-based.
   11. Option to define zones, which will always or never be pixelated.
   12. Option to choose input stream and output stream parameters, including resolutions, frame rate, and encoding.
   13. Utilizes server-side hardware acceleration to maximize the amount of cameras analyzed per server.

2.10 EXISTING GENERAL CLIENT SOFTWARE REQUIREMENTS

A. The Client Software Applications (CSA) provides the user interface for USP configuration and monitoring over any network and be accessible locally or from a remote connection.

B. The CSA will consist of the Configuration UI for system configuration and the Monitoring UI for monitoring. The CSA are Windows-based and provide an easy-to-use graphical user interface (UI).

C. The CSA for monitoring supports running in 64-bit mode.

D. The Server Administrator are used to configure the server database(s). It are web-based and accessible locally on the SSM or across the network.

E. The CSA will seamlessly merge access control, license plate recognition (ALPR), and video functionalities within the same user application.

F. The USP will use the latest user interface (UI) development and programming technologies such as Microsoft WPF (Windows Presentation Foundation), the XAML markup language, and the .NET software framework.

G. All applications provides an authentication mechanism, which verifies the validity of the user. As such, the administrator (who has all rights and privileges) can define specific access rights and privileges for each user in the system.

H. The CSA supports multiple languages, including but not limited to the following: English, French, Arabic, Czech, Dutch, German, Hebrew, Hungarian, Italian, Japanese, Korean, Norwegian, Persian (Farsi), Polish, Portuguese (Brazilian), Simplified and Traditional Chinese, Russian, Spanish, Swedish, Thai, Turkish, and Vietnamese.

I. To enhance usability and operator efficiency, the Configuration UI and Monitoring UI supports many of the latest UI such as:
   1. A customizable Home Page that includes favorite and recently used tasks.
   2. Task-oriented approach for administrator/operator activities where each type of activity (surveillance, visitor management, individual reports, and more) is an operator task.
   3. Consolidated and consistent workflows for video, ALPR, and access control.
   4. Single click functionality for reporting and tracking. The Monitoring UI supports both single-click reporting for access control, ALPR, and video, as well as single-click tracking of areas, cameras, doors, zones, cardholders, elevators, ALPR entities, and more. Single-click reporting or tracking will create a new task with the selected entities to report on or track.

J. Configuration UI and Monitoring UI Home Page and Tasks
   1. The Configuration UI and Monitoring UI are task-oriented.
   2. A task are user interface design patterns whose goal is to simplify the user interface by grouping related features from different systems, such as video and access, in the same display window. Features are grouped together in a task based on their shared ability to help the user perform a specific task.
   3. Tasks are accessible via the Home Page of either the Configuration or the Surveillance CSA.
   4. Newly created tasks are accessible via the Configuration UI or the Monitoring UI taskbar.
   5. Similar tasks are grouped into the following categories:
      a. Operation: Access control management, LRP management, and more.
      b. Investigation: Video bookmark/motion/archive reports, access control activity reports, visitor activity reports, alarm reports, ALPR activity reports, and more.
      c. Maintenance: Access control and video configuration reports, troubleshooters, audit trails, health-related reports, and more.
   6. An operator are able to launch a specific task only if they have the appropriate privileges.
   7. The Home Page content are customizable through the use of privileges to hide tasks that an operator will not have access to and through a list of favorite and recently used tasks. In addition, editing a USP XML file to add new tasks on the

fly will also be possible.

K. The Contractor provides up to 5 simultaneous Clients.

2.11 EXISTING CONFIGURATION USER INTERFACE (UI)

A. General:
1. The Configuration UI application will allow the administrator or users with appropriate privileges to change the system configuration. The Configuration UI provides decentralized configuration and administration of the USP system from anywhere on the IP network.
2. The configuration of all embedded ACS, VMS, and ALPR systems are accessible via the Configuration UI.
3. The Configuration UI will have a home page with single-click access to various tasks.
4. The Configuration UI includes a variety of tools such as troubleshooting utilities, import tools, and a unit discover tool, amongst many more.
5. The Configuration UI includes a static reporting interface to:
   a. View historical events based on entity activity. The user are able to perform such actions as printing a report and troubleshooting a specific access event from the reporting view.
   b. View audit trails that show a history of user/administrator changes to an entity.
6. Common entities such as users, schedules, alarms and many more, can be reused by all embedded systems (ACS, VMS, and ALPR).

B. Video management system:
1. The Configuration UI will allow the administrator or users with appropriate privileges to change video configuration.
2. The Configuration UI provides the ability to change video quality, bandwidth, and frame rate parameters on a per camera (stream) basis for both live and recorded video.
3. The Configuration UI provides the ability to change video quality by a selection of predefined video quality template.
4. The Configuration UI provides the ability to configure brightness, contrast, and hue settings for each camera on the same DVS.
5. The Configuration UI provides the capability to enable audio recording on DVS units that support audio.
6. The Configuration UI provides the ability to change the audio parameters, serial port and I/O configuration of individual DVS units.
7. The Configuration UI provides the capability to rename all DVS units based on system topology and to add descriptive information to each DVS.
8. The Configuration UI provides the ability to set recording schedules and modes for each individual camera. The recording mode can be:
   a. Continuous
   b. On motion and Manual
   c. Manual only
   d. Disabled

9. The Configuration UI supports the creation of schedules to which any of the following functional aspects can be attached:
    a. Video quality (for each video stream per camera)
    b. Recording (for each camera)
    c. Motion detection (for each detection zone per camera)
    d. Brightness, Contrast, and Hue (for each camera)
    e. Camera sequence execution
10. The Configuration UI supports the creation of unlimited recording schedules and the assigning of any camera to any schedule.
11. The Configuration UI will detect and warn user of any conflict within assigned schedules.
12. The Configuration UI provides the capability to set a PTZ protocol to a specific DVS serial port and will allow mixing domes of various manufacturers within a system.
13. User will have the ability to configure a return to home function after a predefined time of inactivity for PTZ cameras. This period of inactivity time are configurable from 1 to 7200 seconds.

2.12 EXISTING VMS CLIENT USER INTERFACE (UI)

A. The Monitoring UI will fulfill the role of a Unified Security Interface that is able to monitor video, ALPR, and access control events and alarms, as well as view live and recorded video.

B. The Monitoring UI provides a graphical user interface to control and monitor the USP over any IP network. It will allow administrators and operators with appropriate privileges to monitor their unified security platform, run reports, and manage alarms.

C. To enhance usability and operator efficiency, the Monitoring UI supports the following UI concepts:
    1. Dynamically adaptive interface that adjusts in real-time to what the operator is doing.
    2. A dynamic controls section loaded with entity-specific widgets (e.g. door and camera widgets).
    3. Use of transparent overlays that can display multiple types of data in a seamless fashion.
    4. Display tile menus and quick commands.
    5. Consolidated and consistent workflows.
    6. Tile menus and quick commands easily accessible within every display tile of the user workspace.
    7. Single click functionality for reporting and tracking. The Monitoring UI supports both single-click reporting for access control, ALPR, and video, as well as single-click tracking of areas, cameras, doors, zones, cardholders, elevators, ALPR entities, and more. Single-click reporting or tracking will create a new task with the selected entities to report on or to track.

D. Monitoring UI Home Page and Tasks:
    1. Similar tasks are grouped into the following categories:

a. Operation: Access control/LRP/video surveillance, visitor management, mustering, access control and video alarm monitoring, and more.
b. Investigation: Video bookmark/motion/archive reports, access control activity reports, visitor activity reports, alarm reports, ALPR activity reports, and more.
c. Maintenance: Access control and video configuration reports, troubleshooters, audit trails, and more.

E. Dynamically Adaptive UI, Controls section, and Widgets:
1. The Monitoring UI will dynamically adapt to what the operator is doing. This are accomplished through the concept of widgets that are grouped in the Monitoring UI Controls section.
2. Widgets are mini-applications or mini-groupings in the Monitoring UI Controls section that let the operator perform common tasks and provide them with fast access to information and actions.
3. With a single click on an entity (for example door or camera) the specific widgets associated to that entity appear and other non-relevant widgets disappear dynamically (instantly). Widgets will bring the operator information such as door status and camera stream information, as well as user actions, such as door unlock, PTZ controls, and more.
4. Specific widgets include those for a door, camera, alarm, zone, display tile, video stream (statistics), PTZ camera, and more.

F. Operator Workflows:
1. A workflow are a sequence of operations an operator or administrator will execute to complete an activity. The “flow” relates to a clearly defined timeline or sequence for executing the activity.
2. The Monitoring UI are equipped with consistent workflows for the ALPR, video, and access control systems that it unifies.
3. Generating or printing a report, setting up or acknowledging an alarm, or creating an incident report will follow the same process (workflow) whether the operator is working with video, ALPR, or access control, or with both video and access control.

G. Each task within the Monitoring UI will consist of one or more of the following items:
1. Event list.
2. Logical tree: Doors, cameras, zones, ALPR units, and elevators are grouped under Areas in a hierarchical fashion.
3. Entities list of all entities being tracked.
4. Display tiles with various patterns (1 x 1, 2 x 2, and more).
5. Display tile menu with various commands related to cameras, doors, PTZ, and tile controls.
6. Controls section with widgets.

H. The Monitoring UI supports multiple event lists and display tile patterns, including:
1. Event/alarm list layout only
2. Display tile layout only
3. Display tile and alarm/event list combination
4. ALPR map and alarm/event list combination

I. User workspace customization
   1. The user will have full control over the user workspace through a variety of user-selectable customization options. Administrators will also be able to limit what users and operators can modify in their workspace through privileges.
   2. Once customized, the user are able to save his or her workspace.
   3. The user workspace are accessible by a specific user from any client application on the network.
   4. Display tile patterns are customizable.
   5. Event or alarm lists will span anywhere from a portion of the screen up to the entire screen and are resizable by the user. The length of event or alarm lists are user-defined. Scroll bars will enable the user to navigate through lengthy lists of events and alarms.
   6. The Monitoring UI supports multiple display tile patterns (for example one display tile (1x1 matrix), 16 tiles (8x8 matrix), and multiple additional variations).
   7. The Monitoring UI supports as many monitors as the PC video adapters and Windows Operating System are capable of accepting.
   8. Additional customization options include: show/hide window panes, show/hide menus/toolbars, show/hide overlaid information on video, resize different window panes, and choice of tile display pattern on a per task basis.

J. The Monitoring UI provides an interface to support the following tasks and activities common to access control, ALPR, and video:
   1. Monitoring the events from a live security system (ACS and/or VMS and/or ALPR).
   2. Generating reports, including custom reports.
   3. Monitoring and acknowledging alarms.
   4. Creating and editing incidents and generating incident reports.
   5. Displaying dynamic graphical maps and floor plans as well as executing actions from dynamic graphical maps and floor plans.
   6. Management and execution of hot actions and macros.

K. The Monitoring UI are able to monitor the activity of the following entities in real-time: areas, ALPR entities, doors, elevators, cameras, cardholders, cardholder groups, zones (input points), and more.

L. The Monitoring UI includes advanced video capabilities, including:
   1. Advanced live video viewing functionality.
   2. Advanced archive playing and video playback functionality.
   3. Monitoring and management of video system events and alarms.
   4. Intercom or duplex audio.
   5. Generation of video reports.
   6. Control of PTZ cameras.
   7. Creating and monitoring archive transfer requests.
   8. Display metadata overlaid on live or playback video.

M. The Monitoring UI will leverage the Graphical Processing Unit (GPU) for video decoding.
   1. The following GPU technologies are supported:
      a. NVidia CUDA

b. Intel Quick Sync

2. The Monitoring UI will have the ability to decode video through the optimal simultaneous use of the GPU and Computer Processing Units (CPU).

N. The live video viewing capabilities of the Monitoring UI includes:
1. The ability to display all cameras attached to the USP and all cameras attached to federated systems.
2. Support for live video monitoring on each and every display tile within a task in the user's workspace.
3. The USP supports uninterrupted video streaming. The CSA will keep existing video connections active in the event that an SSM (except Archiver) becomes unavailable.
4. The ability to drag and drop a camera into a display tile for live viewing.
5. The ability to drag and drop a camera into a display tile for live viewing on an analog monitor connected to an IP hardware decoder (converting an IP encoded stream into an analog video signal).
6. The ability to drag and drop a camera from a map into a display tile for live viewing.
7. Support for digital zoom on live camera video streams.
8. The ability for audio communication with video units with audio input and output.
9. The ability to control pan-tilt-zoom, iris, focus, and presets.
10. The ability to bookmark important events for later retrieval on any archiving camera and to uniquely name each bookmark in order to facilitate future searches.
11. The ability to start/stop recording on any camera in the system that is configured to allow manual recording by clicking on a single button.
12. The ability to activate or de-activate viewing of all system events as they occur.
13. The ability to switch to instant replay of the video for any archiving camera with the simple click of button.
14. The ability to take snapshots of live video and be able to save or print the snapshots.
15. The ability to view the same camera multiple times in different tiles.

O. The video playback (archive playing) capabilities of the Monitoring UI includes:
1. Support for audio and video playback for any time span.
2. Support for video playback on each and every display tile.
3. The ability to instantly replay the video for any archiving camera with the simple click of a button.
4. The ability to select between instant synch of all video streams in playback mode, allowing operators to view events from multiple angles or across several camera fields, or non-synchronous playback.
5. The ability to simultaneously view the same camera in multiple tiles at different time intervals.
6. The ability to control playback with:
   a. Pause
   b. Lock Speed
   c. Forward and Reverse Playback at: 1x, 2x, 4x, 6x, 8x, 10x, 20x, 40x, 100x
   d. Forward and Reverse Playback frame by frame
   e. Slow Forward and Reverse Playback at: 1/8x, 1/4x, 1/3x, 1/2x

f. Loop playback between two time markers

7. The ability to display a single timeline or one timeline for each selected video stream, which would allow the operator to navigate through the video sequence by simply clicking on any point in the timeline.
8. The ability to display the level of motion at any point on a timeline.
9. The ability to clearly display bookmarked events on the timeline(s).
10. The ability to query archived video using various search criteria, including, but not limited to, time, date, camera, and area.
11. The tool necessary for searching video and associated audio based on user-defined events or motion parameters.
12. The ability to define an area of the video field in which to search for motion as well as define the amount of motion that will trigger search results. The Monitoring UI will then retrieve all archived video streams that contain motion that meets the search parameters. There are a graphical timeline on which the time of each search hit are indicated.
13. The ability to browse through a list of all bookmarks created on the system and select any bookmarked event for viewing.
14. The ability to add bookmarks to previously archived video for easier searching and retrieval.
15. Support for digital zoom on playback video streams.
16. Still image export to PNG, JPEG, GIF, and BMP format with Date and Time stamp, and Camera Name on the image (snapshot).
17. Tools for exporting video and a self-contained video player on various media such as USB keys or CD/DVD-ROM. This video player are easy to use without training and will still support reviewing video metadata, such as bookmark, or navigating the video with functions like panoramic camera view dewarping.
18. Tools for exporting video sequences in standard video formats, such as ASF or MP4.
19. The ability to encrypt exported video files.
20. The ability for an operator to load previously exported video files from their computer or network.
21. The ability for queries to be saved upon closing the CSA and reappear when the application is reopened.
22. The ability to dynamically block, on demand, video stream dynamically to lower level users to prevent access, for a specific time, to live and recorded video.
23. A tool building and exporting a set of videos into a single container. This tool will allow the operator to build sequences of video to create a storyboard and allow the export of synchronous cameras.
24. The ability to store the video export and still image export at a pre-defined storage location.
25. An interface with the ability to list, search, and manipulate previously generated video exports.
26. The ability to export sequences of video in open standards including ASF and MP4.

P. The Monitoring UI provides an interface to support the following ALPR tasks and capabilities:
1. Monitoring and management of ALPR events and alarms.
2. Viewing of license plate picture(s) and context images.

3. Viewing of license plate data (e.g. license plate reads)
4. Verification of ALPR data against live and recorded video.

Q. Entity Monitoring:
1. The USP will permit the user to select multiple entities to monitor from the Monitoring UI by adding the entities one by one to the tracking list.
2. The Monitoring UI provides the option to filter which events are displayed in the display tile layout and/or event list layout.
3. It are possible to lock a Monitoring UI display tile so that it only tracks the activity of a specific entity (e.g. specific door or camera).
4. The user are able to drag and drop an event from an event list (or an alarm from an alarm list) onto a display tile to view a license plate read, cardholder picture ID, badge ID, or live/archived video, among other options.
5. Event, alarm, monitoring/tracking, and report lists will contain cardholder pictures where applicable.
6. The user are permitted to start or pause the viewing of events within each display tile.

R. Display Tile Packing and Unpacking:
1. The Monitoring UI supports single-click unpacking and packing for ALPR hits, ALPR reads, areas, doors, zones, camera sequences, and alarms.
2. The packing and unpacking of entities will allow operators to quickly obtain additional information and camera views of a specific entity.
3. The unpacking of an entity will display associated entities. For example, unpacking a door with multiple associated cameras will display all cameras associated with that door. Unpacking will reconfigure the display tiles to be able to display all associated entities. For example, unpacking a door (or a zone or alarm) that is currently in a 1 x 1 tile configuration and that has 3 cameras tied to it will create a 1 x 3 display tile arrangement for viewing all associated entities.
4. Packing will return the display to the original tile pattern.

S. Visual Tracking:
1. The Monitoring UI supports the ability to manually track a moving target with the single click of a button.
2. The ability to switch from one camera view to an adjacent camera are done within a single display tile.
3. Switching between camera streams are accomplished by simply clicking on a semi-transparent shape or overlay.
4. Visual tracking are available with both live and recorded video.

2.13 EXISTING SERVER ADMINISTRATOR USER INTERFACE REQUIREMENTS

A. The Server Administrator are used to configure the SSM and the Directory Role (main configuration) and its database(s), to apply the license, and more.

B. The Server Administrator are a web-based application. Through the Server Administrator, it are possible to access the SSM across the network or locally on the server.

C. Access to the Server Administrator are protected via login name, password, and encrypted communications.

D. The Server Administrator will allow the administrator (user) to perform the following functions:
   1. Manage the system license.
   2. Configure the database(s) and database server for the Directory Role,
   3. Activate/Deactivate the Directory Role.
   4. Manually back up the Directory Role database(s) and/or restore the server database(s), as well as configure scheduled backups of the databases.
   5. Define the client-to-server communications security settings.
   6. Configure the network communications hardware, including connection addresses and ports.
   7. Configure system SMTP settings (mail server and port).
   8. Configure event and alarm history storage options.

2.14 VUNIFIED WEB CLIENT (UWC) GENERAL REQUIREMENTS

A. The USP supports a unified web client (UWC) for access control and video.

B. The UWC are a truly thin client with no download required other than an internet web browser or standard web browser plugins.

C. The UWC are platform independent and run within Microsoft Edge, Internet Explorer, Firefox, Safari, and Google Chrome.

D. Web pages for the web client are managed and pushed by the Web Server Role. Microsoft IIS or any other web hosting service will not be required given that all the web pages are hosted by the Web Server Role.

E. The UWC supports display on tablet format.

F. Video Stream are redirected to the Web Client with no stream transformation or re-encoding for all streams in H264.

G. The Contractor provides up to 5 simultaneous Web Clients.

H. Functionalities:
   1. Log in using name and password or Active Directory support are available.)
   2. Ability for user to change their password.
   3. Encrypted communications for all transactions.
   4. Print reports and export to CSV file.
   5. Customer logo customization are available for multi-tenant and hosted services applications.
   6. Video:
      a. Live and playback video at 320 x 240, 640 x 480 or 1280 x 1024 @ 15 fps
      b. Video export
      c. 1, 4, 6 or 9 tiles
      d. Basic PTZ Controls (Pan/Tilt, Zoom, go to presets, start pattern)

e. Start / Stop recording
f. Sample web page for customers to see how to view video for their own development
g. Add bookmarks

7. Alarms:
   a. Alarm report
8. Threat Level.

2.15 EXISTING SMARTPHONE AND TABLET APP GENERAL REQUIREMENTS

A. The USP supports mobile apps for various off-the-shelf devices. The mobile apps will communicate with the Mobile Server of the USP over any Wi-Fi or cellular network connection.

B. Mobile apps will communicate with the USP via a Mobile Server Role (MSR). All communication between the mobile apps and MSR are based on standard TCP/IP protocol and will use the TLS encryption with digital certificates to secure the communication channel.

C. Supported device manufacturers includes (refer to Mobile App specifications for latest compatibility list):
   1. Apple devices running iOS 11.0 or later
   2. Android devices 6.0 or later

D. It are possible to download the mobile apps from the Central application store (Apple iTunes App Store, Google Play).

E. Functionalities:
   1. Core
      a. Ability to logon/logoff to the USP using an authorized user profile of the system.
      b. Ability to change the picture or the password of the user of the mobile app.
      c. Ability to view the current Threat Level of the system.
      d. Ability to change the current Threat Level of the system.
      e. Ability to execute hot actions configured in the user profile.
      f. Ability to view entities from the USP:
         1) Cameras
         2) Doors
         3) ALPR cameras
         4) Web Tile Plugins
         5) Layouts
         6) Camera Sequences
         7) Macros
      g. Ability to navigate the system hierarchical view of the entities and search entities in the system.
   2. Video
      a. Ability to view live and recorded video from the cameras of the USP. A maximum of four cameras are displayed.
      b. Ability to display live and recorded video side-by-side for a specific camera.

c. Ability to perform digital zoom on cameras.
d. Ability to perform actions on cameras such as add a bookmark, control a PTZ, control the iris/focus function, save a snapshot, start/stop recording.
e. Ability to view camera layouts.
f. Ability to view camera sequences.
g. Ability to run a camera events report.
h. Ability to change the video quality on the cameras displayed on the mobile app.
i. Ability to use the camera of the smartphone and stream a live video feed to a video recorder in the system.

3. Access Control
   a. Ability to view the door state ad door lock state.
   b. Ability to perform actions on a door such as unlock the door, set the door in maintenance mode, override the door unlocking schedule.
4. Automatic License Plate Recognition
   a. Ability to view live events raised by an ALPR camera.
   b. Ability to view the read image, context image, and all metadata captured by the ALPR camera.
   c. Ability to run an ALPR event report.
   d. Ability to add a license plate to a hotlist on the system.
5. Alarm Management
   a. Ability to receive push notifications to notify mobile operators that an alarm was received.
   b. Ability to view all active alarms assigned to the mobile operator.
   c. Ability to perform action on an alarm such as acknowledge, forward, or alternate-acknowledge an active alarm.
   d. Ability to view entities attached to the alarm.
6. Map
   a. Ability to display a geographic map with USP entities geo-located on the map.
   b. Ability to view any entity configured on the map.
   c. Ability to search entities or location on the map.

F. It are possible to send a message from the client user interface to a mobile operator.

G. It are possible to send a live or playback video sequence from the client UI to a mobile operator.

2.16 HEALTH MONITOR

A. The USP will monitor the health of the system, log health-related events, and calculate statistics.

B. USP services, roles, agents, units, and client apps will trigger health events.

C. The USP will populate the Windows Event Log with health events related to USP roles, services, and client apps.

D. A dedicated role, the Health Monitoring Role, performs the following actions:

1. Monitor the health of the entire system and log events.
2. Calculate statistics within a specified time frame (hours, days, months).
3. Calculates availability for clients, servers and video/access/ALPR units.

E. A Health Monitoring task and Health History reporting task are available for live and historical reporting.

F. A Health Monitoring dashboard task are available in the client application user interface to provide a live display, such as pie charts and event lists, for quick visual assessment on the general health of the system.

G. A web-based, centralized health dashboard are available to remotely view unit and role health events of the USP.

H. Detailed system care statistics will be available through a web-based dashboard providing health metrics of USP entities and roles, including Uptime and mean-time-between-failures.

I. All health events raised in the system can be used for automating the USP event/action management.

J. Health events are accessible via the SDK (can be used to create SNMP traps).

2.17 EXISTING USP GENERAL REQUIREMENTS

A. The Unified Security Platform (USP) are an enterprise class IP-enabled security and safety software solution.

B. The USP supports the seamless unification of IP access control system (ACS), IP video management system (VMS), and IP automatic license plate recognition system (ALPR) under a single platform. The USP user interface (UI) applications will present a unified security interface for the management, configuration, monitoring, and reporting of embedded ACS, VMS, and ALPR systems and associated edge devices.

C. Functionalities available with the USP includes:
1. Configuration of embedded systems, such as ACS, ALPR, and VMS systems.
2. Live event monitoring.
3. Live video monitoring and playback of archived video.
4. Alarm management.
5. Reporting, including creating custom report templates and incident reports.
6. Dynamic graphical map viewing.
7. Asset management system integration. (Specifier, Professional and up, additional license required)

D. The USP are deployed in one or more of the following types of installations:
1. Unified access, ALPR, video platform, and any combination thereof.
2. Standalone access control, ALPR, or video platform.
3. Unified access and video platform that federates multiple remote ACS, VMS, ALPR.

4. Standalone video platform that federates multiple independent remote VMS.
5. Standalone access control that federates multiple independent remote ACS.
6. Standalone access control that federates multiple independent remote ALPR.

E. Licensing:
1. A single central license are applied centrally on the configuration server.
2. There are no requirement to apply a license at every server computer or client workstation.
3. Based on selected options, one or more embedded systems are enabled or disabled.

F. Hardware and Software Requirements:
1. The USP and embedded systems (video, license plate recognition, and access control) are designed to run on a standard PC-based platform loaded with a Windows operating system. The preferred operating system are coordinated with the Owner following the manufacturer supported operating systems.
2. The core client/server software are built in its entirety using the Microsoft .NET software framework and the C# (C-Sharp) programming language.
3. The USP database server(s) are built on Microsoft's SQL Server. The preferred SQL version are coordinated with the Owner and compatible with the USP.
4. The USP are compatible with virtual environments, including VMware and Microsoft Hyper-V.
5. The USP will use the latest user interface (UI) development and programming technologies such as Microsoft WPF (Windows Presentation Foundation), the XAML markup language, and .NET software framework.

2.18 EXISTING USP ARCHITECTURE

A. The USP are based on a client/server model. The USP will consist of a standard Server Software Module (SSM) and Client Software Applications (CSA).

B. The USP are an IP enabled solution. All communication between the SSM and CSA are based on standard TCP/IP protocol and will use TLS encryption with digital certificates to secure the communication channel.

C. The SSM are a Windows service that can be configured to start when the operating system is booted and run in the background. The SSM will automatically launch at computer startup, regardless of whether or not a user is logged on the machine.

D. Users are able to deploy the SSM on a single server or across several servers for a distributed architecture. The USP will not be restricted in the number of SSM deployed.

E. The USP protects against potential database server failure and continue to run through standard off-the-shelf solutions.

F. The USP supports an unrestricted number of logs and historical transactions (events and alarms) with the maximum allowed being limited by the amount of hard disk space available.

G. The USP supports uninterrupted video streaming. The CSA will keep existing video connections active in the event that an SSM (except Archiver) becomes unavailable.

H. Roles-Based Architecture:
   1. The USP will consist of a role-based architecture, with each SSM hosting one or more roles.
   2. Each role will execute a specific set of tasks related to either core system, automatic license plate recognition (ALPR), video (VMS), or access control (ACS) functionalities, among many others. Installation are streamlined through the ability of the USP to allow administrators to:
      a. Deploy one or several SSM across the network prior to activating roles.
      b. Activate and deactivate roles as needed on each and every SSM.
      c. Centralize role configuration and management.
      d. Support remote configuration.
      e. Move roles over from one SSM to another.
   3. Each role, where needed, will have its own database to store events and role-specific configuration information.
   4. Roles without databases, such as The Federation feature, Active Directory, and Global Cardholder Management, supports near real-time standby without any third party failover software being required.
   5. Directory Role:
      a. The Directory Role will manage the central database that contains all the system information and component configuration of the USP.
      b. The Directory Role will authenticate users and give access to the USP based on predefined user access rights or privileges, and security partition settings.
      c. The Directory Role supports the configuration/management of the following components common to the ACS, ALPR, and VMS sub-systems:
         1) Security Partitions, users and user groups
         2) Areas
         3) Zones, input/output (IO) linking rules, and custom output behavior
         4) Alarms. Schedules, and scheduled tasks
         5) Custom events
         6) Macros or custom scripts
      d. The Directory Role supports the configuration/management of the following components specific to VMS:
         1) Video servers and their peripherals (e.g. audio, IOs, and serial ports)
         2) PTZ
         3) Camera sequences
         4) Recording and archiving schedules
      e. The Directory Role supports the configuration/management of the following components specific to ACS:
         1) Door controllers, and input and output (IO) modules
         2) Doors, Elevators, and Access rules
         3) Cardholders and cardholder groups, credentials, and badge templates
      f. The Directory Role supports the configuration/management of the following components specific to ALPR:
         1) ALPR units and cameras
         2) Hotlists, permit lists, and overtime rules
   6. The Video Archiver Role are responsible for managing cameras and encoders

under its control and archiving.

7. The Media Router Role are responsible for routing video and audio streams across local and wide area networks from the source (for example DVS) to the destination (for example CSA).
8. The Access Manager Role are responsible for synchronizing access control hardware units under its control, such as door controllers and I/O modules. This role will also be responsible for validating and logging all access activities and events when the door controllers and I/O modules are online.
9. The Automatic License Plate Recognition (ALPR) Role are responsible for synchronizing fixed ALPR units (cameras) and mobile ALPR applications under its control. The ALPR Role will also be responsible for logging all ALPR activities and events.
10. The Zone Manager Role are responsible for managing all software zones (collection of inputs) and logging associated zone events. Zones will consist of inputs from both access control and video devices.
11. The Health Monitoring Role are responsible for monitoring and logging health events and warnings from the various client applications, roles, and services that are part of the USP. This role will also be responsible for logging events within the Windows Event Log and for generating reports on health statistics and health history.

I. Server Monitoring Service (Watchdog):

1. The USP includes a Server Monitoring Service that continuously monitors the state of the Server Software Module (SSM) service.
2. The Server Monitoring Service are a Windows service that automatically launches at system startup, regardless of whether or not a user is logged into his account.
3. The Server Monitoring Service are installed on all PCs/servers running an SSM. In the event of a malfunction or failure, the Server Monitoring Service will restart the failed service. As a last resort, the Server Monitoring Service will reboot the PC/server will it be unable to restart the service.

2.19 EXISTING USP ACCESS CONTROL, VIDEO, AND ALPR UNIFICATION

A. The Monitoring UI will present a true Unified Security Interface for live monitoring and reporting of the ACS, VMS, and ALPR. Advanced live video viewing and playback of archived video are available through the Monitoring UI.

B. The Configuration UI will present a true Unified Security Interface for the configuration and management of the ACS, VMS, and ALPR.

C. The user are able to associate one or more video cameras to the following entity types: areas, doors, elevators, zones, alarms, intrusion panels, ALPR cameras, and more.

D. It are possible to view video associated to access control events when viewing a report.

E. It are possible to view video associated to intrusion panel events when viewing a

report.

F. It are possible to view video associated to ALPR events when viewing a report.

G. The USP supports the following Alarm Management functionality:
   1. Create and modify user-defined alarms. An unrestricted number of user-defined alarms are supported.
   2. Assign a time schedule or a coverage period to an alarm. An alarm are triggered only if it is a valid alarm for the current time period.
   3. Set the priority level of an alarm and its reactivation threshold.
   4. Define whether to display live or recorded video, still frames or a mix once the alarm is triggered.
   5. Provide the ability to display live and recorded video within the same video tile using picture-in-picture (PiP) mode.
   6. Provide the ability to group alarms by source and by type.
   7. Define the time period after which the alarm is automatically acknowledged.
   8. Define the recipients of an alarm. Alarm notifications are routed to one or more recipients. Recipients are assigned a priority level that prioritizes the order of reception of an alarm.
   9. Define the alarm broadcast mode. Alarm notifications are sent using either a sequential or an all-at-once broadcast mode.
   10. Define whether to display the source of the alarm, one or more entities, or an HTML page.
   11. Specify whether an incident report is mandatory during acknowledgment.

H. The workflows to create, modify, add instructions and procedures, and acknowledge an alarm are consistent for access control, ALPR, and video alarms.

I. Alarms are federated, allowing global alarm management across multiple independent USP, ACS, VMS, and ALPR systems.

J. The USP will also support alarm notification to an email address or any device using the SMTP protocol.

K. The ability to create alarm-related instructions are supported through the display of one or more HTML pages following an alarm event. The HTML pages are user-defined and can be interlinked.

L. Alarm unpacking and packing are supported where all the entities associated to an alarm can be display in the Monitoring UI with the single click of a button.

M. The user will have the ability to acknowledge alarms, create an incident upon alarm acknowledgement, and put an alarm to snooze.

N. The user are able to spontaneously trigger alarms based on something they see in the system.

O. An alarm are configured in such a way that it remains visible until the source condition has been acknowledged.

P. The user are able to investigate an alarm without acknowledging it.

2.20 EXISTING USP REMOTE TASK

A. The USP provides, through a Remote Task, capabilities to remotely monitor and control the content of other workstations running the CSA (Monitoring UI) that are part of the same system.

B. The USP supports video wall applications by connecting and controlling multiple workstations and monitors simultaneously.

C. The Remote Task are a graphical interface showing a replication of the remote workstation running the CSA (Monitoring UI).

D. The Remote Task will allow the connection to other workstations using a low bandwidth mode to receive only snapshots of video viewed remotely.

E. The Remote Task will allow the connection to other workstations using a spy mode to remain invisible to the remotely connected workstation. The spy mode option are available to the user with permission to access the feature.

F. The functionality provided by the remote monitoring and control capability includes:
   1. Remote monitoring and control of the monitoring and alarm monitoring tasks.
   2. Ability to remotely switch cameras, doors and zones into display tiles.
   3. Ability to remotely control live and playback video.
   4. Ability to remotely change the tile pattern.
   5. Ability to remotely create and delete tasks.
   6. Ability to remotely start/stop task cycling.
   7. Ability to remotely go into full screen mode.
   8. Ability to remotely save and reload the workspace.

2.21 EXISTING USP ADVANCED TASK MANAGEMENT

A. USP supports an infrastructure for managing Monitoring UI tasks used for live monitoring, day to day activities, and reporting.

B. Administrators are able to assign tasks and lock the operator’s workspace. The user management of their workspace are limited by their assigned privileges.

C. Operators are able save their tasks as either Public tasks or Private tasks and in a specific partition. Public tasks are available to all users. Private tasks will only be available to the owner of the task.

D. Operators are able to share their tasks by sending them to one or more online users. Recipients will have the option to accept the sent task.

E. Operators are able to duplicate a task.

2.22 EXISTING USP REPORTING

A. The USP supports report generation (database reporting) for access control, ALPR, video, and intrusion.

B. Each and every report in the system are a USP task, each associated with its own privilege. A user will have access to a specific report task if they have the appropriate privilege.

C. The workflows to create, modify, and run a report are consistent for access control, ALPR, and video reports.

D. Reports are federated, allowing global consolidated reporting across multiple independent USP, ACS, VMS, and ALPR systems.

E. Access control and ALPR reports supports cardholder pictures and license plate pictures, respectively.

F. The USP supports the following types of reports:
   1. Alarm reports
   2. Video-specific reports (archive, bookmark, motion, and more)
   3. Configuration reports (cardholders, credentials, units, access rules, readers/inputs/outputs, and more)
   4. Activity reports (cardholder, cardholder group, visitor, credential, door, unit, area, zone, elevator, and more)
   5. ALPR-specific reports (mobile ALPR playback, hits, plate reads, reads/hits per day, reads/hits per ALPR zone, and more)
   6. Health activity and health statistics reports
   7. Other types of reports, including visitor reports, audit trail reports, incident reports, and time and attendance reports

G. Generic Reports, Custom Reports, and Report Templates:
   1. The user will the option of generating generic reports from an existing list, generating reports from a list of user-defined templates, or creating a new report or report template.
   2. The user are able to customize the predefined reports and save them as new report templates. There are no need for an external reporting tool to create custom reports and report templates. Customization options includes setting filters, report lengths, and timeout period. The user will also be able to set which columns are visible in a report. The sorting of reported data are available by clicking on the appropriate column and selecting a sort order (ascending or descending).
   3. All report templates are created within the Monitoring UI.
   4. These templates can be used to generate reports on a schedule in PDF or Excel formats.
   5. An unrestricted number of custom reports and templates are supported.

H. A reporting task layout will consist of panes with settings (report length, filters, go and reset commands, etc.), the actual report data in column format, and a pane with display tiles. The user are able to drag and drop individual records in a report onto

one or more display tiles to view a cardholder's picture ID, playback a video sequence, or an ALPR event.

I. The USP supports comprehensive data filtering for most reports based on entity type, event type, event timestamp, custom fields, and more.

J. The reporting task will have the ability to display results through graphics such as line charts, bar charts, stacked bar charts, doughnut charts, and pie charts.

K. The user are able to click on an entity within an existing report to generate additional reports from the Monitoring UI.

L. The USP supports the following actions on a report: print report, export report to a PDF/Microsoft Excel/CSV file, export the graphics chart in JPG/PNG, and automatically email a report based on a schedule and a list of one or more recipients.

2.23 EXISTING USP DASHBOARDS

A. The USP supports the ability to create dashboards.

B. Operators are allowed to view dashboards if they are granted the appropriate privilege. Modification to dashboards will also be allowed to users granted the appropriate privilege.

C. Dashboards in the system are a USP task. A user will have access to a specific dashboard task if they have the appropriate privilege.

D. Dashboards are saved either in a private folder or a public folder.

E. A dashboard will consist of a canvas with carious widgets displayed on the canvas. All widgets offers the ability to specify location and size to the widget, a title to the widget, a background color to the widget, and the ability to refresh periodically the content of the widget.

F. Dashboard widget types are:
   1. Image: provides the ability to display an image (JPG, PNG, GIF, BMP) on a dashboard.
   2. Text: provides the ability to display a text on a dashboard. The text style are configurable, so font, size, color, and alignment can be specified by the user.
   3. Tile: provides the ability to display any entity of the USP inside of a tile.
   4. Web page: provides the ability to display a URL on a dashboard.
   5. Entity Count: provides the ability to display the total number of a specific entity type in the USP.
   6. Reports: provides the ability to display the results of any saved reports in the system. The results are displayed either by showing the total number of results in the report, a set of top results from the report, or a visual graph from the data returned by the report.

G. It are possible to extend to the widgets of a dashboard using the SDK. This will

provide the ability to develop custom widgets to the system.

H. The USP supports the following actions on a dashboard: print dashboard, export dashboard to PNG file, and automatically email a report based on a schedule and a list of one or more recipients.

2.24 EXISTING USP ZONE MANAGEMENT

A. The USP supports the configuration and management of zones for input point monitoring via the Zone Manager Role. A user are able to add, delete, or modify a zone if they have the appropriate privileges.

B. A zone will monitor the status of one or more inputs points. Zone monitoring or input point monitoring are possible through the use of a controller and one or more input modules. Inputs from video cameras or video encoders will also be accessible via a zone.

C. Depending on the hardware installed, supervised inputs are supported. Depending on the input module used, both 3-state and 4-state supervision are available.

D. A schedule are defined for a zone, indicating when the zone will be monitored.

E. Custom Events provides full flexibility in creating custom events tailored to a zone. Users are able to associate custom events to state changes in monitored inputs.

F. The ACS supports one or more cameras per zone. Video will then be associated to zone state changes.

G. Input/Output (IO) Linking:
   1. Zone management supports Input/Output (IO) Linking. I/O Linking will allow one or more inputs to trigger one or more outputs.
   2. IO Linking are available in offline mode when communication between the server and hardware is not available.
   3. Custom Output Behaviors provides full flexibility in creating a variety of complex output signal patterns: simple pulses, periodic pulses, variable duty-cycle pulses, and state changes.
   4. Through the “trigger an output” action, the ACS supports the triggering of outputs with custom output behaviors.

2.25 EXISTING USP USER AND USER GROUP SECURITY, PARTITIONS, AND PRIVILEGES MANAGEMENT

A. The USP supports the configuration and management of users and user groups. A user are able to add, delete, or modify a user or user group if they have the appropriate privileges.

B. The USP supports user authentication with claims-based authentication using external providers. External providers includes:

1. ADFS (Active Directory Federation Services)

C. Common access rights and privileges shared by multiple users are defined as User Groups. Individual group members will inherit the rights and privileges from their parent user groups. User group nesting are allowed.

D. User privileges are extensive in the USP. All configurable entities for the USP, including access control, video, and ALPR will have associated privileges.

E. Specific entities, such as cardholders, cardholder groups, and credentials includes a more granular set of privileges, such as the right to access custom fields and change the activation or profile status of an entity.

F. Partitions:
1. The USP limits what users can view in the configuration database via security partitions (database segments). The administrator, who has all rights and privileges, are allowed to segment a system into multiple security partitions.
2. All entities that are part of the USP can be assigned to one or more partitions.
3. A user who is given access to a specific partition will only be able to view entities (components) within the partition to which they have been assigned. Access is given by assigning the user as an accepted user to view the entities that are members of a particular partition.
4. A user or user group can be assigned administrator rights over the partition.

G. It are possible to specify user and user group privileges on a per partition basis.

H. Advanced logon options are available such as dual logon and more.

I. It are possible to specify an inactive period for the Monitoring UI after which time the application will automatically lock, while still preserving access to currently displayed camera feeds.

J. It are possible to review user permissions and determine:
1. For any entity in the system, which user group or user can view or modify it.
2. For any user group or user in the system, what are its privileges.
3. For any privilege in the system, which user group or user is allowed to perform the underlying action.

2.26 EXISTING USP EVENT/ACTION MANAGEMENT

A. The USP supports the configuration and management of events for video and ALPR. A user are able to add, delete, or modify an action tied to an event if he has the appropriate privileges.

B. The USP will receive all incoming events from one or more ACS, VMS, and/or ALPR. The USP will take the appropriate actions based on user-define event/action relationships.

C. The USP will receive and log the following events:

1. System-wide events
2. Application events (clients and servers)
3. Area, camera, door, elevator, and ALPR events (reads and hits)
4. Unit events
5. Zone events
6. Alarm events
7. ALPR events
8. Health Monitoring events

D. The USP will allow the creation of custom events.

E. The USP will have the capability to execute an action in response to an access control, video, and ALPR event. The USP supports the following list of actions, without being limited to:
1. Add bookmark
2. Arm intrusion detection area
3. Arm zone
4. Block and unblock video
5. Bypass input
6. Cancel postpone intrusion detection area arming
7. Clear input bypass
8. Clear task
9. Display a camera on an analog monitor
10. Display an entity in the CSA
11. Email a report
12. Email a snapshot
13. Export report
14. Forgives antipassback violation
15. Go home
16. Go to preset
17. Import from file
18. Override recording quality
19. Override with event recording quality
20. Override with manual recording quality
21. Play a sound
22. Postpone intrusion detection area arming
23. Reboot unit
24. Recording quality as standard configuration
25. Rest area people count
26. Reset parking zone inventory
27. Run a macro
28. Run a pattern
29. Send a message
30. Send a task
31. Send an email
32. Set parking zone occupancy
33. Set reader mode
34. Set the door maintenance mode
35. Set threat level

36. Start/Stop applying video protection
37. Start/Stop recording
38. Start/Stop transfer
39. Synchronize role
40. Temporary override elevator schedules
41. Trigger intrusion alarm
42. Trigger alarm
43. Trigger output
44. Trigger read
45. Unlock door explicitly

F. The USP will allow a schedule to be associated with an action. The action are executed only if it is an appropriate action for the current time period.

2.27 EXISTING USP SCHEDULES AND SCHEDULED TASKS

A. Schedules
1. The USP supports the configuration and management of complex schedules. A user are able to add, delete, or modify a schedule if they have the appropriate privileges.
2. The USP provides full flexibility and granularity in creating a schedule. The user are able to define a schedule in 1-minute or 15-minute increments.
3. Daily, weekly, ordinal, and specific schedules are supported.

B. Scheduled Tasks
1. The USP supports scheduled tasks for video, and ALPR.
2. Scheduled tasks are executed on a user-defined schedule at a specific day and time. Recurring or periodic scheduled tasks will also be supported.
3. Scheduled tasks supports all standard actions available within the USP, such as sending an email or emailing a report.

2.28 EXISTING USP MACROS AND CUSTOM SCRIPTS

A. The USP will enable users to automate and extend the functionalities of the system through the use of macros or custom scripts for access control, video, and ALPR.

B. Custom macros are created with the USP Software Development Kit (SDK).

C. A macro are executed either automatically or manually.

D. In the Monitoring UI, a macro are launched through hot actions.

2.29 EXISTING USP AUDIT AND USER ACTIVITY TRAILS (LOGS)

A. The USP supports the generation of audit trails. Audit trails will consist of logs of operator/administrator additions, deletions, and modifications.

B. Audit trails are generated as reports. They are able to track changes made within specific time periods. Querying on specific users, changes, affected entities, and time periods will also be possible.

C. For entity configuration changes, the audit trail report includes detailed information of the value before and after the changes.

D. The USP supports the generation of user activity trails. User activity trails will consist of logs of operator activity on the USP such as login, camera viewed, ALPR event viewed, badge printing, video export, and more.

E. The ACS supports the following actions on an audit and activity trail report: print report and export report to a PDF/ Microsoft Excel/CSV file.

2.30 EXISTING USP SOFTWARE DEVELOPMENT KIT (SDK)

A. A USP SDK are available to support custom development for the platform.

B. The SDK includes functionalities specific to the embedded automatic license plate recognition (ALPR), access control (ACS), and video (VMS) systems.

C. Integration with external applications and databases are possible with the SDK.

D. The SDK will enable end-users to develop new functionality (user interface, standalone applications or services) to link the USP to third party business systems and applications, such as Badging Systems, Human Resources Management Systems (HRMS), and Enterprise Resource Planning (ERP) systems.

E. The SDK are based on the .NET framework.

F. The SDK supports dynamic or transactional updates to the USP configuration. It will also support change notification of USP entity configuration.

G. The SDK provides an extensive list of programming functions to view and/or configure core entities such as: users and user groups, alarms, custom events, and schedules, and more.

H. The SDK provides an extensive list of programming functions to view and configure ACS, VMS, and ALPR.

I. The SDK provides an extensive list of programming functions to view and configure most ACS entities such as: cardholders, cardholder groups, visitors, credentials, access rules (modify only), and custom fields.

J. The SDK are able to receive real time events from the following USP entities: users and user groups, areas, zones, cameras, video units, doors, door controllers (units), elevators, cardholders, cardholder groups, and credentials.

K. The SDK are able to query the history of events for areas, cameras, zones, alarms,

cardholders, credentials, visitors, doors, query license plate read events, license plate hit events, generate a license plate hits report, generate a license plate reads report.

L. The SDK supports the following alarm functions: view alarms in real time, acknowledge alarms, change priority, and change recipient.

PART 3 - EXECUTION

3.1 WARRANTY

A. The product performs in all material respects in accordance with the accompanying user manual, and the media on which the Software Product resides will be free from defects in materials and workmanship under normal use. Software defects are covered through Service Releases and Cumulative Updates which are available for a period of 1 year from the date of the software purchase.

B. Extended warranty, up to 5 years, are available through the purchase of the Genetec Advantage support service which includes the following additional services over the standard warranty:
   1. Access to phone support and online chat for technical assistance
   2. Online case management
   3. Online system availability monitor
   4. Access to Major and Minor Release Upgrades

3.2 DEPLOYMENT SERVICES AND SYSTEM COMMISSIONING

A. General Requirements:
   1. The contractor will engage the services of the USP vendor to assist in the management of the deployment of the USP at the end-user site on projects that involve:
      a. Multiple contractors or subcontractors that will be responsible for deploying the USP at multiple client sites in different geographical regions.
      b. Complex enterprise installations involving advanced functionality (for example The Federation feature, failover, plugins) and/or multiple systems (for example access control, video, ALPR) and/or third party integrations.
      c. Extensive use of customized solutions/plugins developed by the vendor that will be integrated into the USP.
   2. The USP vendor services includes Deployment Management and System Configuration and Commissioning.

B. Deployment Management Service:
   1. The Deployment Management service from the vendor includes a Project Manager acting as the single point of contact for all communications between the contractor and the vendor organization and who will be responsible for:
      a. Conducting a Risk Assessment of the impact of potential risk factors on the operation of the vendor's USP.
      b. Providing a project plan for the deployment of the vendor's USP.

c. Managing the development and deployment of the custom solution components that will be integrated into the vendor's USP (if applicable).
d. Providing a scope of work detailing the services to be provided by the vendor to assist in the deployment of the vendor's USP.
e. Coordinating and scheduling the vendor field services with the contractor to assist with the deployment of the vendor's USP.
f. Providing regular project status updates to the contractor regarding the development of custom solutions (if applicable) and the deployment of the vendor's USP.

C. Solution Architect Service:
1. The Solution Architect service from the vendor includes a Solutions Architect Engineer acting as a single technical point of contact throughout the deployment of the USP, and who will be responsible for:
a. Assisting the contractor/subcontractor with the design and architecture of the vendor's USP.
b. Conducting technical consultation activities that may include fit/gap analysis, system design reviews, device compatibility assessments, functional and technical design reviews as well as performance reviews of the vendor's USP.
c. Conducting a system assessment and ensuring best practices of the vendor's USP are followed.
d. Providing upgrade and migration strategy for the vendor's USP where applicable.
e. Providing documentation regarding the system architecture, system design, hardware specifications and compatibility requirements, camera bandwidth calculations, and best practices as they relate to the vendor's USP.

D. System Configuration and Commissioning Service:
1. The System Configuration and Commissioning service from the vendor includes a Field Engineer who will be responsible for:
a. Assisting the contractor's or subcontractor's onsite/remote technicians with the configuration and commissioning of the vendor's USP at the client site.
b. Conducting a test of the USP following the deployment of the system using real-world operator scenarios to ensure optimal system performance.
c. Providing the contractor with a Service Report detailing the tasks completed during the deployment of the USP at the client site, as well as any recommendations for improving the performance of the USP that must be implemented by the contractor.
d. Providing a knowledge transfer of the vendor's USP to the contractor following the deployment of the USP at the client site.

3.3 MANUFACTURER END USER OPERATOR TRAINING

A. The contractor will engage the services of the USP vendor to assist in the end user training of the USP at the end-user site. Training are no less than 8 hours for up to 20 people. Contractor provides video recording of operator training, and provided it to the agency for future training of staff.

END OF SECTION

SECTION 28 31 00

FIRE ALARM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes fire alarm systems.

1.3 DEFINITIONS

A. FACP: Fire alarm control panel.

B. LED: Light-emitting diode.

C. NICET: National Institute for Certification in Engineering Technologies.

D. Definitions in NFPA 72 apply to fire alarm terms used in this Section.

1.4 SYSTEM DESCRIPTION

A. Addressable system; multiplexed signal transmission dedicated to fire alarm service with speaker/strobes. This system shall be capable of handling the entire fire system requirements of the building including, but not limited to fire sprinkler monitoring, magnetic door hold open equipment, HVAC equipment, Elevator Recall and voice evacuation speaker/strobes throughout the entire building.

1.5 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 72.

B. Premises protection includes Fully Sprinkled Type Occupancy.

C. Fire alarm signal initiation shall be by one or more of the following devices:
1. Manual stations.
2. Heat detectors.
3. Smoke detectors.
4. Verified automatic alarm operation of smoke detectors.
5. Automatic sprinkler system water flow.
6. Fire standpipe system.
7. Post indicator Valve

1.6 FIRE ALARM SIGNAL SHALL INITIATE THE FOLLOWING ACTIONS:

A. Alarm notification appliances shall operate continuously.

B. Identify alarm at the FACP and remote annunciators.

C. De-energize electromagnetic door holders.

D. Transmit an alarm signal to the remote alarm receiving station.

E. Unlock electric door locks in designated egress paths.

F. Release fire and smoke doors held open by magnetic door holders.

G. Activate voice/alarm communication system.

H. Switch heating, ventilating, and air-conditioning equipment controls to fire alarm mode.

I. Close smoke dampers in air ducts of system serving zone where alarm was initiated.

J. Record events in the system memory with ability to be printed.

1.7 SUPERVISORY SIGNAL INITIATION SHALL BE BY ONE OR MORE OF THE FOLLOWING DEVICES OR ACTIONS:

A. Operation of a fire-protection system valve tamper.

B. Operation of any duct detectors or induct detectors.

1.8 SYSTEM TROUBLE SIGNAL INITIATION SHALL BE BY ONE OR MORE OF THE FOLLOWING DEVICES OR ACTIONS:

A. Open circuits, shorts and grounds of wiring for initiating device, signaling line, and notification-appliance circuits.

B. Opening, tampering, or removal of alarm-initiating and supervisory signal-initiating devices.

C. Loss of primary power at the FACP.

D. Ground or a single break in FACP internal circuits.

E. Abnormal ac voltage at the FACP.

F. A break in standby battery circuitry.

G. Failure of battery charging.

H. Abnormal position of any switch at the FACP or annunciator.

I. Fire-pump power failure, including a dead-phase or phase-reversal condition.

J. Low-air-pressure switch operation on a dry-pipe or preaction sprinkler system.

A. System Trouble and Supervisory Signal Actions: Annunciate at the FACP and remote annunciators. Record the event on system memory with ability to be printed.

1.9 SUBMITTALS

A. Prior to the start of work, the contractor shall provide a complete and comprehensive submittal for review by the engineer. Once the engineer of record has reviewed and approved the submittal, the contractor shall provide a complete submittal to the Authority Having Jurisdiction for their review and approval. The contractor is responsible for obtaining and paying for the fire alarm permits that may be required. The submittals shall be prepared by a NICET III certified, factory trained personnel. This person shall provide to the engineer of record the proof of NICET certification and proof of factory training if requested. Factory training means that this person has received training at the factory. These are to describe the proposed system and its equipment. Failure to provide a complete submittal shall be grounds for summary rejection of any incomplete submittal documentation. Contractors who provide re-submittal's, due to prior rejection shall be subject to a re-review fee, should the Engineer elect to do so. The complete submittal shall include, but not be limited to, all of the following material:

B. Power Calculations
1. Battery capacity calculations shall be a minimum of 125% of the calculated requirement.
2. Supervisory power requirements for all equipment.
3. Alarm power requirements for all equipment.
4. Power supply rating justification showing power requirements for each of the system power supplies. Power supplies shall be sized to furnish the total connected load in a worst case condition plus 25% spare capacity.
5. Voltage-drop calculations for wiring runs demonstrating worst case condition.

C. Complete manufacturers catalog data including supervisory power usage, alarm power usage, physical dimensions, finish and mounting requirements.

D. Complete drawings covering the following shall be submitted by the contractor for the proposed system. Floor plans in a CAD compatible format showing all equipment and raceways, marked for size, conductor count with type and size, showing the percentage of allowable National Electric Code fill used. Floor plans will be prepared at 1/8" scale.

E. A complete proposed system database including a description of all logic strings, control by event programming and point identification labels on a flash drive and in a formatted printed form, as required for offsite editing, shall be submitted for evaluation by the owner.

1. The program shall include all required interactive control functions between the local network systems and the methods for implementing these actions.

F. Provide the address, telephone number, and contact person(s) of the manufacturer's local service facility for normal and off-hour warranty issues.

G. If the fire alarm system and its equipment are supplied by a manufacturer's distributor, as part of the submittal documentation, the manufacturer shall provide, on its corporate letterhead, a "letter of support". Said "letter of support" shall state that, when in the opinion of the Engineer, the distributor's efforts require back-up and/or assistance, the manufacturer shall provide, at no cost to the Owner, all required technical support during the installation phase and for a one (1) year guarantee period starting on the date of final acceptance by the owner and the authority having jurisdiction. If said "letter of support" is not submitted, the manufacturer's equipment will be deemed unacceptable and shall be grounds for summary rejection.

H. Provide a fire alarm system function matrix. Matrix shall illustrate alarm output events in association with initiating devices input events. Matrix shall represent a summary of the installed system alarm, supervisory and trouble functions. Include any and all departures, exceptions, variances or substitutions from these specifications and/or drawings at the time of bid. Failure to provide this requirement shall be cause for summary rejection of submittal documents where additional departures are discovered. (See NFPA-72 for minimum matrix requirements)

I. For each system control panel and/or transponder panel, provide panel ampere loading during both normal and alarm modes, with time calculations to substantiate compliance with battery back-up power requirements (battery Ampere-Hour capacity), described elsewhere in these specifications.

J. For each system control panel and/or transponder panel, provide written schedule of active and spare addresses provided on each addressable circuit to substantiate compliance with circuit usage/spare requirements, described elsewhere in these specifications.

K. For each system control panel and system transponder notification appliance circuit provide a written schedule of spare capability in amperes available for future possible use.

L. Provide manufacture’s printed product data, catalog pages and descriptions of any special installation requirements and/or procedures. Drawings depicting any special physical installation requirements shall show physical plans, elevations, all dimensions, conduit entry, minimum access clearances and any other details required.

M. Provide shop drawings as follows:

1. Drawing or catalog page showing actual dimensions of the main FCS.
2. Drawing(s) or catalog page(s) showing actual dimensions of any additional system control panels, and/or battery cabinets.
3. Drawing or catalog page showing actual dimensions of the remote annunciator(s).
4. Single line riser diagram showing, all equipment, all connections and number and size of all conductors and conduits.
5. Provide samples of various items when so requested by the engineer.

N. The fire protection contractor shall provide copies of certification for service technician's formal training by the system manufacture. As a minimum, certification documents shall indicate training dates, systems qualified, name of individual certified and current status.

O. Product Data: For each type of product indicated within 90 days of notice to proceed.

P. Within 30 days of notice to proceed, the contractor shall submit a programming printout and digital copy of the program to the Engineer for review.

Q. Qualification Data: For Installer: NICET Level III certification within 30 days of notice to proceed.

R. Field quality-control test reports: provide test reports 10 days prior to final test requirements.

S. Operation and Maintenance Data: For fire alarm system to include in emergency, operation, and maintenance manuals. Comply with NFPA 72, recommendations for Owner's manual. Include abbreviated operating instructions for mounting at the FACP.

T. Documentation:
1. Approval and Acceptance: Provide the "Record of Completion" form according to NFPA 72 to Owner, Engineer, and authorities having jurisdiction.
2. Record of Completion Documents: Provide the "Permanent Records" according to NFPA 72 to Owner, Engineer, and authorities having jurisdiction. Format of the written sequence of operation shall be the optional input/output matrix.
   a. Hard copies on paper to Owner, Engineer, and authorities having jurisdiction.
   b. Electronic media may be provided to Engineer.

1.10 QUALITY ASSURANCE

A. Installer Qualifications: Personnel certified by NICET as Fire Alarm Level III.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. 30 days after award of bid, the contractor shall conduct a meeting with the owner; owners representative, the Engineer and the Engineer to discuss compliance of the specifications and drawings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

B. Manufacturers: College of Southern Idaho has sole source documentation to standardize campus to non-proprietary fire alarm systems:
   1. FACP and Equipment:
      a. Silent Knight by Honeywell
   2. Wire and Cable:
      a. Comtran Corporation.
      b. Helix/HiTemp Cables, Inc.; a Draka USA Company.
      c. Rockbestos-Suprenant Cable Corporation; a Marmon Group Company.
      d. West Penn Wire/CDT; a division of Cable Design Technologies.
   3. Audible and Visual Signals:
      a. System Sensor
      b. Wheelock
      c. Gentex
      d. Other UL listed devices

2.2 FACP

A. General Description:
   1. Modular, power-limited design with electronic modules, UL 864 listed.
   2. Addressable initiation devices that communicate device identity and status.

B. Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at the FACP.

C. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.

D. Addressable control circuits for operation of mechanical equipment.

E. Alphanumeric Display and System Controls: Arranged for interface between human operator at the FACP and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

F. Annunciator and Display: Liquid-crystal type, three line(s) of 80 characters, minimum.

G. Keypad: Arranged to permit entry and execution of programming, display, and control commands; and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.

H. Circuits:

1. Signaling Line Circuits: NFPA 72, Class B.
   a. System Layout: Each signaling line circuit shall be loaded no more than 80% capacity.

I. Notification-Appliance Circuits: NFPA 72, Class A.

J. Actuation of alarm notification appliances, annunciation, smoke control, shall occur within 10 seconds after the activation of an initiating device.

K. Electrical monitoring for the integrity of wiring external to the FACP for mechanical equipment shutdown and magnetic door-holding circuits is not required, provided a break in the circuit will cause doors to close and mechanical equipment to shut down.

L. Smoke-Alarm Verification:
   1. Initiate audible and visible indication of an "alarm verification" signal at the FACP.
   2. Activate a listed and approved "alarm verification" sequence at the FACP and the detector.
   3. Sound general alarm if the alarm is verified.
   4. Cancel FACP indication and system reset if the alarm is not verified.

M. Notification-Appliance Circuit: Operation shall sound in a temporal pattern, complying with ANSI S3.41.

N. Power Supply for Supervision Equipment: Supply for audible and visual equipment for supervision of the ac power shall be from a dedicated dc power supply, and power for the dc component shall be from the ac supply.

O. Alarm Silencing, Trouble, and Supervisory Alarm Reset: Manual reset at the FACP and remote annunciators, after initiating devices are restored to normal.
   1. Silencing-switch operation halts alarm operation of notification appliances and activates an "alarm silence" light. Display of identity of the alarm zone or device is retained.
   2. Subsequent alarm signals from other devices or zones reactivate notification appliances until silencing switch is operated again.
   3. When alarm-initiating devices return to normal and system reset switch is operated, notification appliances operate again until alarm silence switch is reset.

P. Walk Test: A test mode to allow one person to test alarm and supervisory features of initiating devices. Enabling of this mode shall require the entry of a password. The FACP and annunciators shall display a test indication while the test is underway. If testing ceases while in walk-test mode, after a preset delay, the system shall automatically return to normal.

Q. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and control of changes in those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and make a print-out of the final adjusted values on the system printer.

R. Service Modem: Ports shall be RS-232 for system printer and for connection to a dial-in terminal unit.

S. The dial-in port shall allow remote access to the FACP for programming changes and system diagnostic routines. Access by a remote terminal shall be by encrypted password algorithm.

T. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signal, supervisory signal supervisory and digital alarm communicator transmitter shall be powered by the 24-V dc source.

U. The alarm current draw of the entire fire alarm system shall not exceed 80 percent of the power-supply module rating.

V. Power supply shall have a dedicated fused safety switch for this connection at the service entrance equipment. Paint the switch box red and identify it with "FIRE ALARM CIRCUIT."

W. Secondary Power: 24-V dc supply system with batteries and automatic battery charger and an automatic transfer switch.
1. Batteries: Vented, wet-cell pocket, plate nickel cadmium.
2. Battery and Charger Capacity: Comply with NFPA 72.

B. Surge Protection:
3. Install surge protection on normal ac power for the FACP and its accessories. Comply with Division 26 Section "Transient Voltage Suppression" for auxiliary panel suppressors.
4. Install surge protectors recommended by FACP manufacturer. Install all system wiring external to the building housing the FACP.

X. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.3 FIRE ALARM DOCUMENT CABINET

A. General Description:
1. Minimum 18 gauge steel construction
2. Textured, baked on red enamel finish
3. Business card holder
4. Key ring hooks
5. Legend sheet for passwords and system information
6. Cover shall have white lettering that reads “SYSTEM RECORD DOCUMENTS”

2.4 ADDRESSABLE INITIATION MANUAL FIRE ALARM BOXES

A. Description: UL 38 listed; finished in red with molded, raised-letter operating instructions in contrasting color. Station shall show visible indication of operation.

Mounted on recessed outlet box; if indicated as surface mounted, provide manufacturer's surface back box.

1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type. With integral addressable module, arranged to communicate manual-station status (normal, alarm, or trouble) to the FACP.
2. Station Reset: Key- or wrench-operated switch.
3. Indoor Protective Shield: Factory-fabricated clear plastic enclosure, hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible tone intended to discourage false-alarm operation.

2.5 SYSTEM SMOKE DETECTORS

A. General Description:
1. UL 268 listed, operating at 24-V dc, nominal.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
3. Retain subparagraph above or first subparagraph and associated subparagraphs below, or both. If retaining both, indicate detector types on Drawings.
4. Multipurpose type, containing the following:
5. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
6. Heat sensor, combination rate-of-rise and fixed temperature.
7. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. Provide terminals in the fixed base for connection of building wiring.
8. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
9. Integral Visual-Indicating Light: LED type. Indicating detector has operated and power-on status.
10. Where noted on drawings provide a welded wire screen protective cover.
11. Retain subparagraph and associated subparagraphs below for analog-addressable system where remotely adjustable detectors are to be used. If both standard-addressable and analog-addressable devices are required, indicate device types on Drawings.
12. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACP.
13. The number of FACP settable levels varies among manufacturers and between detector types. Indicate the specific number of levels on Drawings or in the "Remarks" column of a detector schedule.
14. Provide multiple levels of detection sensitivity for each sensor.

B. Photoelectric Smoke Detectors:
1. Sensor: LED or infrared light source with matching silicon-cell receiver.
2. Verify detector sensitivity below with manufacturers selected.
3. Detector Sensitivity: Between 2.5 and 3.5 percent/foot (0.008 and 0.011 percent/mm) smoke obscuration when tested according to UL 268A.

C. Edit first paragraph and subparagraphs below to suit Project. Coordinate with Drawings.

D. Duct Smoke Detectors:
   1. Photoelectric Smoke Detectors:
      a. Sensor: LED or infrared light source with matching silicon-cell receiver.
      b. Verify detector sensitivity below with manufacturers selected. Increased and decreased sensitivities are available to meet special environmental requirements.
      c. Detector Sensitivity: Between 2.5 and 3.5 percent/foot (0.008 and 0.011 percent/mm) smoke obscuration when tested according to UL 268A.

E. Retain subparagraph and associated subparagraphs above for photoelectric smoke detectors or first subparagraph and associated subparagraphs below for ionization smoke detectors. If both types are required, indicate detector types on Drawings.

F. UL 268A listed, operating at 24-V dc, nominal.

G. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.

H. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. The fixed base shall be designed for mounting directly to the air duct. Provide terminals in the fixed base for connection to building wiring.

   a. Weatherproof Duct Housing Enclosure: UL listed for use with the supplied detector. The enclosure shall comply with NEMA 250 requirements for Type 4X.

I. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.

J. Integral Visual-Indicating Light: LED type. Indicating status. Provide remote status and alarm indicator and test station where indicated.

K. Each sensor shall have multiple levels of detection sensitivity.

L. Sampling Tubes: Design and dimensions as recommended by manufacturer for the specific duct size, air velocity, and installation conditions where applied.

M. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

2.6 NOTIFICATION APPLIANCES

A. Description: Equipped for mounting as indicated and with screw terminals for system connections.

1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly.
2. Where called for on plans to have a wire guard, provide and install a welded wire screen guard of appropriate size. Polycarbonate or other transparent protective covers are prohibited.

B. Revise sound-level values in first four paragraphs below to comply with local interpretations of ADA requirements. See Editing Instruction No. 10 in the Evaluations.

C. Speakers: 400 to 4,000 Hz, mylar cone, sealed back construction 24-V dc; with provision for housing the operating mechanism behind a grille. Speakers shall produce a sound-pressure level of 15 dBA above ambient maximum sound level having a duration of at least 60 seconds, measured 5 feet above the floor.

D. Visible Alarm Devices: Xenon strobe lights listed under UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- (25-mm-) high letters on the lens.
1. Retain one of two subparagraphs below to suit Project or revise light output to comply with NFPA 72 and ADA minimum requirements. Delete first subparagraph if rated light output is indicated on Drawings. See Editing Instruction No. 11 in the Evaluations.
2. Rated Light Output: as indicated.
3. Strobe Leads: Factory connected to screw terminals.
4. Where called for on plans to have a wire guard, provide and install a welded wire screen guard of appropriate size. Polycarbonate or other transparent protective covers are prohibited.

2.7 SPRINKLER SYSTEM REMOTE INDICATORS

A. Remote status and alarm indicator and test stations, with LED indicating lights. Light is connected to flash when the associated device is in an alarm or trouble mode. Lamp is flush mounted in a single-gang wall plate. A red, laminated, phenolic-resin identification plate at the indicating light identifies, in engraved white letters, device initiating the signal and room where the smoke detector or valve is located. For water-flow switches, the identification plate also designates protected spaces downstream from the water-flow switch.

2.8 MAGNETIC DOOR HOLDERS

C. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching door plate.
1. Electromagnet: Requires no more than 3 W to develop 25-lbf (111-N) holding force.
2. Wall-Mounted Units: Flush mounted, unless otherwise indicated.
3. Rating: 24-V dc.

B. Material and Finish: Match door hardware.

2.9 REMOTE ANNUNCIATOR

A. Description: Duplicate annunciator functions of the FACP for alarm, supervisory, and trouble indications. Also duplicate manual switching functions of the FACP, including acknowledging, silencing, resetting, and testing.

10. Mounting: Flush cabinet, NEMA 250, Class 1.

B. Display Type and Functional Performance: Alphanumeric display same as the FACP. Controls with associated LED's permit acknowledging, silencing, resetting, and testing functions for alarm, supervisory, and trouble signals identical to those in the FACP.

2.10 ADDRESSABLE INTERFACE DEVICE

A. Description: Microelectronic monitor module listed for use in providing a system address for listed alarm-initiating devices for wired applications with normally open contacts.

B. Integral Relay: Capable of providing a direct signal to the elevator controller to initiate elevator recall where indicated to a circuit-breaker shunt trip for power shutdown and to release doors.

2.11 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Listed and labeled according to UL 632.

B. Functional Performance: Unit receives an alarm, supervisory, or trouble signal from the FACP, and automatically captures one or two telephone lines and dials a preset number for a remote central station. When contact is made with the central station(s), the signal is transmitted. The unit supervises up to two telephone lines. Where supervising 2 lines, if service on either line is interrupted for longer than 45 seconds, the unit initiates a local trouble signal and transmits a signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. When telephone service is restored, unit automatically reports that event to the central station. If service is lost on both telephone lines, the local trouble signal is initiated.

C. Secondary Power: Integral rechargeable battery and automatic charger. Battery capacity is adequate to comply with NFPA 72 requirements.

D. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.12 GUARDS FOR PHYSICAL PROTECTION

A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.
1. Factory fabricated and furnished by manufacturer of the device.
2. Finish: Paint of color to match the protected device.

2.13 WIRE AND CABLE

A. Wire and cable for fire alarm systems shall be UL listed and labeled as complying with

NFPA 70, Article 760.

B. Signaling Line Circuits: Twisted, shielded pair, not less than No. 18 AWG size as recommended by system manufacturer.

C. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.

11. Line-Voltage Circuits: No. 12 AWG, minimum.

D. All wire and cable shall be installed in conduit.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Smoke or Heat Detector Spacing:
1. Smooth ceiling spacing shall not exceed [30 feet (9 m)] .
2. Spacing of heat detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas, shall be determined according to Appendix A in NFPA 72.
3. Spacing of heat detectors shall be determined based on guidelines and recommendations in NFPA 72.

B. HVAC: Locate detectors not closer than 3 feet (1 m) from air-supply diffuser or return-air opening.

C. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of the duct.

D. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.

E. Coordinate first paragraph below with Drawings.

F. Audible Alarm-Indicating Devices: as first option, Install on ceiling or in celling tile. Where ceiling height or construction is not favorable for ceiling installation, install speaker strobe between 80” and 96” above finished floor, this height is to the visual lens portion of the device, or on ceiling. Install bells and speakers on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.

G. Visible Alarm-Indicating Devices: Install integral to each alarm speaker if noted.

H. Device Location-Indicating Lights: Locate in public space near the device they monitor.

I. FACP: Surface mount with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.

J. Annunciator: Install with top of panel not more than 72 inches (1830 mm) above the finished floor.

K. Fire alarm document cabinet shall be located adjacent to the fire alarm control panel or at another location that has been approved by the AHJ. If not located at the fire alarm control panel, the exact location shall be identified on the fire alarm control panel.

3.2 WIRING INSTALLATION

A. Install wiring according to the following:
1. NECA 1.
2. TIA/EIA 568-A.

B. Wiring Method: Install wiring in metal raceway according to Division 26 Section "Raceways and Boxes."
1. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.

C. Wiring Method:
1. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.
2. Fire-Rated Cables: Use of 2-hour fire-rated fire alarm cables, NFPA 70 Types MI and CI, is not permitted.
3. Signaling Line Circuits: Power-limited fire alarm cables may be installed in the same cable or raceway as signaling line circuits.

D. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

E. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

F. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

G. Wiring to Remote Alarm Transmitting Device: 1-inch (25-mm) conduit between the FACP and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals according to Division 26 Section "Electrical Identification."

B. Install instructions frame in a location visible from the FACP.

C. Paint power-supply disconnect switch red and label "FIRE ALARM CIRCUIT."

D. The location of the branch-circuit overcurrent protective devices shall be permanently identified at the fire alarm control unit.

3.4 GROUNDING

A. Ground the FACP and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to the FACP.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Testing Agency: Owner will engage a qualified testing and inspecting agency to witness field tests and inspections and prepare test reports. The contractor shall provide all personnel for this test. There shall be two tests, one prior to the Fire Marshall test and one with the Fire Marshall.

C. Perform the following field tests and inspections and prepare test reports:
   1. Before requesting final approval of the installation, submit a written statement using the form for Record of Completion shown in NFPA 72.
   2. Perform each electrical test and visual and mechanical inspection listed in NFPA 72. Certify compliance with test parameters.
   3. Visual Inspection: Conduct a visual inspection before any testing. Use as-built drawings and system documentation for the inspection. Identify improperly located, damaged, or nonfunctional equipment, and correct before beginning tests.
   4. Testing: Follow procedure and record results complying with requirements in NFPA 72.

D. At no time shall the contractor make changes to the documents without written permission from the Engineer.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the fire alarm system, appliances, and devices. Refer to Division 1 Section "Closeout Procedures and Demonstration and Training."

END OF SECTION 283100

PART 4 -

Site and Infrastructure

SECTION 31 00 00

EARTHWORK

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide all labor, materials, and equipment as required for all excavation, grading, providing borrow materials, hauling, placing and compacting earthwork materials to construct the site to the grades shown on the plans.

B. Prior to commencement of any earthwork, the Contractor shall review the geotechnical reports. The geotechnical report is on file at the office of the Engineer for information only and the Contractor is responsible for making any interpretations there from.

C. Submit to the Engineer's Field Representative load tickets on all materials delivered to the site.

1.2 REFERENCE STANDARDS

A. ASTM D 136 Sieve Analysis of Fine and Coarse Aggregates

B. ASTM D 422 Method for Particle - Size Analysis of Soils

C. ASTM D 698 Test Methods for Moisture-Density Relations of Soils and Soil-Aggregated Mixtures, Using 5.5-lb Rammer and 12-inch Drop

D. ASTM D 1556 Density of Soil by the Sand-Cone Method

E. ASTM D 1557 Test Methods for Moisture-Density Relations of Soils and Soil Aggregate Mixtures, Using 10 lb. Rammer and 10 inch Drop

F. ASTM D 1633 Test Method for Compressive Strength of Molded Soil-Cement Cylinders

G. ASTM D 2419 Test Method for Sand Equivalent Value of Soils and Fine Aggregate

H. ASTM D 2487 Classification of Soils for Engineering Purposes

I. ASTM D 2901 Test Method for Cement Control of Freshly-Mixed Soil Cement

J. ASTM D 2922 Density of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth).

K. ASTM D 4254 Test Methods for Minimum Index Density of Soils and Calculative of Relative Density

L. OSHA - 1926.650-651 and other applicable sections.

1.3 SUBMITTALS

A. The Contractor shall submit test results of all materials proposed to be used in work in accordance with the requirements of Section 01 33 00 - Submittal Procedures.

B. Submit sieve analysis, moisture density relationship test for both ASTM D698 and D1557, and sand equivalency. The sieve analysis and moisture density relationship tests must have been completed within 12 calendar months from the date of submittal.

1.4 DEFINITIONS

A. Backfill or Fill: (a) Material used to replace material removed during construction or (b) The act of replacing or placing material during construction.

B. Backfill Operation or Fill Operation: The method and the activity required to fill surface depressions and excavations, or to construct fills to required grades.

C. Common Fill: Fill or borrow materials which are naturally occurring and not meeting a specific gradation or classification.

D. Structural Fill: The act of placing common or imported fill material under controlled operation to a certain density.

PART 2 - PRODUCTS

2.1 SUITABLE FILL AND BACKFILL MATERIAL REQUIREMENTS

A. The following types of suitable materials are defined (see Execution for the location where the materials are approved for use or where identified in other specifications and drawings):

1. Common Fill: Fill or borrow materials which are naturally occurring, not meeting a specific gradation or classification, are not Unsuitable Materials, and can be placed in a controlled operation to a certain density.

2. Sand Backfill (Bedding Sand): Sand with 100 percent passing a 3/8-inch sieve, at least 90 percent passing a Number 4 sieve and less than 3% passing the No. 200 sieve.

3. Crushed Stone Backfill (Bedding Chips): Manufactured angular, crushed stone, crushed rock, or crushed slag with the following gradation requirements:

Sieve Size	Percent Passing By Weight
1”	100
3/4"	80 - 100
3/8”	20 - 70
No. 4	5 - 20
No. 200	0 - 3

4. Coarse Gravel (Drain Rock): Crushed rock or gravel which is free of shale, clay, friable materials, and or debris that conforms to the gradation below. Drain Rock shall have a minimum of 35% Air Voids as determined by ASTM C 29 Standard Test Method for Unit Weight and Voids in aggregate, Jigging Procedure.

Sieve Size	Percent Passing By Weight
3”	100
1”	25 - 60
3/8”	0 - 4
200	0 - 2

5. Aggregate Base (3/4” Road Mix): Crushed aggregate base material of such nature that it can be compacted readily by watering and rolling to form a firm, stable base. The material shall meet the following gradation requirements:

Sieve Size	Percent Passing By Weight
1”	100
3/4"	90 - 100
No. 4	40 - 65
No. 8	30 - 50
No. 200	3 - 9

a. The sand equivalent value shall be not less than 30, sand equivalent not required if less than 5% passing the No. 200 sieve

b. The material shall have a Los Angeles Abrasion of 35% or less.

6. Aggregate Subbase (Pit Run): Uncrushed rock aggregate subbase material that can be compacted readily by watering and rolling to form a firm stable subbase. The material shall meet the following requirements:

Sieve Size	Percent Passing By Weight
4”	100
3”	90-100
No. 4	30-75
No. 200	0 – 15.0

   a. The sand equivalent value shall be not less than 30, sand equivalent not required if less than 5% passing the No. 200 sieve.

   b. The material shall have a Los Angeles Abrasion of 40% or less.

7. Granular Borrow: Provide sand, sand and gravel, or sand and rock mixtures with a sand equivalent greater than 30. Sand equivalent is not required if the material has less than 5 percent passing the No. 200 sieve.

8. Gravel Surfacing: Meet the following requirements for gravel surfacing, including added binder or blending material:

Sieve Size	Percent Passing By Weight
3/4"	100
No. 4	40-80
No. 10	25-60
No. 200	8-20

   a. Dust Ratio: the portion passing the No. 200 (0.075 mm) sieve cannot exceed two-thirds of the portion passing the No. 40 (0.425 mm) sieve.

   b. For material passing the No. 40 (0.425 mm) sieve, the liquid limit must not exceed 35 and the plasticity index must not be below 6 or above 12.

   c. A wear factor not exceeding 40% at 500 revolutions.

   d. At least 35% by weight of the aggregate retained on the No. 4 (4.75 mm) sieve must have one fractured face.

9. Filter Sand: Aggregate of natural sand or other approved inert materials composed of hard, strong, and durable particles conforming to the requirements of ASTM C-33 except as modified herein.

   a. Use only aggregates that include deleterious substances not exceeding the following:

Type	Percent Passing By Weight
Clay Lumps	0.50
Coal and Lignite	0.30
Other Deleterious Substances	2.00
Deleterious Material passing No. 200	1.75

   b. Moisture content of fine aggregate shall not exceed 8 percent.

   c. Aggregate that is uniformly graded from coarse to fine within the following gradation as follows:

Sieve Size	Percent Passing By Weight
3/8”	100
No. 4	95 - 100
No. 16	45 - 80
No. 50	10 - 30
No. 100	2 - 10
No. 200	0 - 4

2.2 UNSUITABLE MATERIALS

A. Unsuitable material include the materials listed below:

1. Soils which, when classified under ASTM D 2487 – Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System), fall in the classification of Pt, OH, CH, MH, or OL.

2. Soils which cannot be compacted sufficiently to achieve the density specified for the intended use.

3. Materials that contain hazardous or designated waste materials including petroleum hydrocarbons, pesticides, heavy metals, and any material which may be classified as hazardous or toxic according to applicable regulations.

4. Soils that contain greater concentrations of chloride or sulfate irons, or have a soil resistively or pH less than the existing on-site soils.

PART 3 - EXECUTION

3.1 PREPARATION

A. Notify Engineer prior to starting any grading operations.

B. Identify required lines, levels, contours and datum.

C. Identify and flag surface and aerial utilities, known underground utilities locations.

D. Maintain and protect existing utilities which pass through the work area.

3.2 SITE CONTROL

A. Unfavorable Weather: Do not place, spread, or roll any fill material during unfavorable weather conditions. Do not resume operations until moisture content of material is satisfactory.

B. Flooding: Provide berms or channels to prevent flooding or saturation of subgrade. Promptly remove all water collecting in depressions.

C. Softened Subgrade: Where soil has been softened or eroded by flooding or placement during unfavorable weather, remove all damaged areas and recompact as specified for fill.

D. Dust Control: Use all means necessary to control dust on and near the work and on and near all off-site borrow areas. Thoroughly moisten all surfaces as required to prevent dust from being a nuisance to the public, neighbors, residents, properties, and concurrent performance of other work on the site.

E. Noise Control: Use equipment that is equipped with adequate noise attenuation devices.

3.3 OFF-SITE IMPACTS

A. Comply with all traffic and hauling requirements of the State and County.

B. Provide all signing, flagmen, or other special traffic control required to provide for the safety of the public.

C. Use only vehicles approved for highway use and comply with all load requirements.

D. Provide wheel cleaning as required to minimize the tracking of materials onto public roadways.

3.4 PROTECTION

A. Protect trees and other features to remain as a portion of the final landscaping or project.

B. Protect bench marks, existing structures, fences, sidewalks, paving, and curbs from equipment and vehicular traffic.

C. Protect above and below grade utilities which are to remain.

D. Notify Engineer of unexpected subsurface conditions and discontinue affected work in the area until notified to resume work.

E. Protect bottom of excavations and soil adjacent to and beneath foundation from frost.

F. Grade excavation top perimeter to prevent surface water runoff into excavation.

3.5 EXCAVATION

A. Excavate all cut areas to the grades shown on the plans.

B. Excavate all areas that have excessive moisture content and cannot be compacted to the required densities.

C. Correct unauthorized excavation at no cost to the Owner.

D. Excavate or scarify and aerate soils with excessive moisture content, and allow to dry.

3.6 SUBGRADE PREPARATION

A. Excavate to subgrade elevation.

B. In the presence of a materials testing company, thoroughly proofroll with a loaded tandem-axle dump truck with a minimum weight of 20 tons, or 40-ton static roller.

C. Areas where soft or disturbed conditions are identified, excavate, remove and dispose of unsuitable soft spot material. If the material is suitable except for excessive moisture content, scarify and dry the material to the acceptable moisture content, or replace with Engineer approved materials, and recompact to the density of the material to place over the area.

D. The Contractor’s materials testing company to submit a subgrade inspection report noting the means and methods used to proofroll the subgrade and any corrections or repairs made.

3.7 PREPARATION OF FOUNDATION

A. Building Subgrade:

1. Per Geotechnical Report.

B. All other areas:

1. Per Geotechnical Report.

3.8 CONSTRUCTION OF EMBANKMENTS

A. Fill areas to contours and elevations as shown on the plans. Do not use frozen materials.

B. Place and compact fill materials in continuous lifts not exceeding six (6) inches in depth, unless specifically allowed.

C. Employ a placement method so as not to disturb or damage utilities in trenches.

D. Maintain optimum moisture content of materials to attain required compaction density.

E. Make smooth changes in grade. Blend slopes into level areas.

3.9 IMPORTED STRUCTURAL FILL

A. Aggregate Subbase and Base, granular borrow, and common fill material under parking areas, drive lanes, and vehicle traffic areas, shall be compacted to at least 95% of the maximum dry density as determined in accordance with ASTM D698. Maximum loose lift thickness for aggregate base shall not exceed 8 inches. Maximum loose lift thickness for aggregate subbase, granular borrow, and common fill shall not exceed 10 inches.

B. Aggregate Subbase and Base material under buildings, including 4 feet outside the building area, and under equipment pads shall be compacted to at least 95% of the maximum dry density as determined in accordance with ASTM D1557. Maximum loose lift thickness for aggregate base shall not exceed 8 inches and aggregate subbase shall not exceed 10 inches.

C. Granular material with more than 30% by weight retained on the 3/4-inch sieve shall be compacted to a minimum 75 percent of maximum index density as determined by ASTM D4253 and D4254. Drain rock and crushed stone backfill material does not require compaction.

3.10 DISPOSAL OF WASTE SOIL

A. Contractor shall dispose of waste material at an off-site location determined by the Contractor.

3.11 QUALITY CONTROL

A. Material & Compaction Testing: All materials testing of samples will be performed by a testing agency Contracted by the Owner. The Contractor is responsible for coordination with the Owner's testing professional. If tests indicate work does not meet specific compaction requirements, remove work, replace, and retest at the Contractor's expense.

1. Qualifications of testing company

a. Basic requirements of ASTM E 329, "Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials as Used in Construction" and ASTM D 3666, "Standard Specification for Minimum Requirements for Agency Testing and Inspecting Bituminous Paving Materials", as applicable.

b. Calibrate testing equipment at reasonable intervals by devices of accuracy traceable to either the National Bureau of Standards or accepted values of natural physical constants.

2. Frequency of Compaction Tests

a. Curbs and sidewalks: In horizontal plane, test at start with subsequent tests a maximum of every 250 feet. At landscape islands test each island at one location. At every horizontal location, obtain one test at subgrade. Perform subsequent tests every 12 inches of compacted depth and at top of backfill or when materials or procedures change. Perform a minimum of two (2) tests at finished grade.

b. Parking and vehicle areas, roadways: In horizontal plane, test each backfill area with subsequent test for every 2,500 square feet of backfill surface area. At every horizontal location, obtain one test at subgrade. Perform subsequent tests every 12 inches of compacted depth and at top of backfill or when materials or procedures change.

c. Concrete slabs for buildings, patios, concrete plaza, and entry slabs: In horizontal plane, test each backfill area with subsequent test for every 1,000 square feet of backfill surface area. At every horizontal location, obtain one test at subgrade. Perform subsequent tests every 12 inches of compacted depth and at top of backfill or when materials or procedures change.

d. Linear foundations and footings: In horizontal plane, test at start with subsequent tests a maximum of every 100 feet, and where elevation changes between adjacent footings. At every horizontal location, obtain one test at subgrade. Perform subsequent tests every 12 inches of compacted depth and at top of backfill or when materials or procedures change. Perform a minimum of two (2) tests at finished grade.

e. Along exterior basement walls and retaining walls: In horizontal plane, test each backfill area with subsequent test for every 100 lineal feet of wall, a minimum of two test per exterior wall side, At every horizontal location, obtain one test at subgrade. Perform subsequent tests every 12 inches of compacted depth and at top of backfill or when materials or procedures change.

3.12 TOLERANCES

A. Finished grade of graded areas shall meet the following requirements:

1. In paved areas including roadways, sidewalks, parking lots, etc., plus or minus 0.10 feet from the grade shown on the plans.

2. Building pads, plus or minus 0.05 feet from the grade shown on the plans.

3. In landscaped areas or similar areas, plus or minus two (2) inches.

4. Differential grades between walking surfaces shall not exceed 1/4-inch.

5. Landscape finish grade adjacent to concrete walks shall be minus 1-inch from walking surface elevation.

END OF SECTION

SECTION 31 05 19

GEOTEXTILES FOR EARTHWORK

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish and install geotextiles as specified herein and as indicated on the drawings.

1.2 SUBMITTALS

A. Certificates: Submit geotextile manufacturer's certified test results showing that the geotextiles meet the requirements of these specifications.

B. Submit manufacturer's installation instructions and maintain copy at the jobsite.

PART 2 - PRODUCTS

2.1 GENERAL

A. Geotextiles shall be composed only of long chain polymeric (at least 85% polyolephins, polyesters or polyamides) filaments or yarns oriented into a stable network that retains its relative structure (including selvages) during handling, placement, and design service life.

2.2 SUBGRADE SEPARATION GEOTEXTILE

A. Verify geotextile delivered to the site meets the requirements of this specification.

B. Subgrade Separation Geotextile fabric shall be woven or non-woven, with the following minimum properties:

Geotextile Property (Roll Values)	Test Method	Requirement
*Grab Tensile Strength – lb (in either principal direction)	ASTM D 4632	270 / 180
*Grab Elongation (%)	ASTM D 4632	<50% / ≥50%
*Puncture Strength – lb	ASTM D 6241	600 / 450
*Trapezoidal Tear Strength – lb	ASTM D 4533	100 / 75
Apparent Opening Size (AOS) (Standard Sieve)	ASTM D 4751 COE CW-002215	#30 or finer
Permittivity (sec-1)	ASTM D 4491	0.02
*For geotextiles with elongation which is less than 50%, the first strength value is applied. For geotextiles with elongation which is equal to or greater than 50%, the second strength value is applied. Higher strength is required for geotextiles with lower elongations.		

2.3 DRAINAGE GEOTEXTILE

A. Drainage Geotextile fabric shall be non-woven, with the following minimum properties:

Geotextile Property (Roll Values)	Test Method	Requirement
Grab Tensile Strength – lb (in either principal direction)	ASTM D 4632	≥80
Puncture Strength – lb	ASTM D 6241	≥300
Apparent Opening Size (AOS) (Standard Sieve)	ASTM D 4751	#70 or finer
Permittivity (sec-1)	ASTM D 4491	0.7

PART 3 - EXECUTION

3.1 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Protect geotextiles against damage and excessive sunlight during shipment and storage.

3.2 EXAMINATIONS

Verify that surfaces upon which the geotextile is to be installed are graded to a smooth, uniform condition free of obstructions, depressions, and debris.

3.3 GENERAL PLACEMENT REQUIREMENTS

A. Spread geotextile immediately ahead of the covering operation. Do not drag the geotextile on the ground or mishandle in any way. Place the geotextile loosely and without wrinkles so that placement of the overlying material will not tear the geotextile.

B. Place the cover material on the geotextile in such a manner that a minimum of 12 inches of material will be between the equipment tires or tracks and the geotextile at all times.

C. Cover the geotextile with the specified cover material as soon as possible. Geotextiles which have not been ultraviolet stabilized shall not remain uncovered for longer than 7 days. Ultraviolet stabilized materials shall not remain exposed longer than 30 days.

3.4 PLACEMENT IN SOFT GROUND

A. Where geotextiles will be placed over soft ground, construction vehicles shall not drive directly on the geotextile material. End-dumping the cover material directly on the geotextile will not be permitted. Under no circumstances shall cover material be dropped on unprotected geotextile from a height greater than 3 ft. above the surface of the geotextile.

B. Limit compaction of the first lift above the geotextile over soft ground to operation of placing and spreading equipment only. No sheep foot type equipment will be allowed on the first lift. Subsequent lifts will be closely observed during compaction. If any foundation failures occur during compaction operations, lightweight compaction equipment shall be used. Use pegs, pins, or the manufacturer's recommended methods as needed to hold the geotextile in place until the specified cover material is placed. Seams that have separated will require the removal of fill and the required overlap reestablished. Repair at no cost to the Owner.

3.5 REPAIRS

A. Should the geotextile be torn, punctured or the overlaps joints disturbed, as evidenced by visible geotextile damage, subgrade pumping, intrusion, or pad or roadbed distortion, remove the backfill around the damaged or displaced area and repair or replace the damaged geotextile at no cost to the Owner.

B. The repair shall consist of a patch of the same type of geotextile placed over the ruptured area. The patch shall overlap the existing geotextiles a minimum of 2 feet from the edge of the rupture.

3.6 JOINT OVERLAP

A. Subgrade Separation: Overlap the geotextile a minimum of 2 feet at all joints.

B. Drainage Application: Overlap the geotextile a minimum of 12 inches at all joints. In trenches less than 12 in. wide, overlap shall be the width of the trench.

C. Weed Barrier: Overlap the geotextile a minimum of 6 inches at all joints.

END OF SECTION

SECTION 31 11 00

CLEARING AND GRUBBING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide removal of trees, stumps, shrubs, grass and other vegetation within the construction limits to permit construction of the new facilities.

B. Protect the adjoining properties from damage during clearing and grubbing operations.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 CLEARING AND GRUBBING

A. Clearing and grubbing shall extend to no more than 3 feet outside of the construction limits. The clearing and grubbing operation shall be conducted in a manner which will not damage any vegetation outside of the clearing and grubbing limits. All brush, roots, and other debris within the grubbing limits shall be removed to a depth of 6". Completely remove stumps and other debris protruding through the subgrade surface. The Contractor shall chop all brush and debris resulting from the Clearing and Grubbing operation and haul to a disposal site located by the Contractor off-site. Burning of debris on-site will not be allowed.

3.2 STRIPPING

A. Areas within the limits of the project shall be stripped to remove topsoil containing organic material before construction begins over such areas. The topsoil shall not be used in construction of onsite fills or trench backfills. The topsoil shall be hauled to a disposal site located by the Contractor off-site.

END OF SECTION

SECTION 31 23 33

TRENCHING AND BACKFILLING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide all excavation of trenches, bedding, and backfilling work for construction of piping.

B. Excavation of trenches shall include all material excavated or removed regardless of type, character, composition or condition of the material.

1.2 SUBMITTALS

A. The Contractor shall submit samples of all materials proposed to be used in work. Sample sizes shall be determined by the testing laboratory.

1.3 DEFINITIONS

A. Pipe Zone: That portion of the vertical trench cross-section lying between a plane below the bottom surface of the pipe and a plane 6 inches above the top of the pipe.

B. Trench Zone: The portion of the vertical trench cross-section lying between the Pipe Zone and a point 18 inches below the finished grade.

C. Final Backfill: The portion of the vertical trench cross-section within 18 inches of finished grade.

D. Pipe Bedding: Material placed below the pipe and in the Pipe Zone.

E. Springline: The center axis of the pipe.

F. Trench Backfill: Material placed from the top of the Pipe Zone to finished grade.

G. Trench Foundation Material: Material placed below the Pipe Bedding.

PART 2 - PRODUCTS

2.1 PIPE BEDDING MATERIAL

A. Pipe bedding shall consist of crushed stone backfill (bedding chips) material per Section 31 00 00 - Earthwork.

2.2 TRENCH BACKFILL MATERIAL

A. Excavated trench material may be used as follows:

1. Excavated trench material shall be free from cinders, ashes, refuse, organic and frozen material, boulders with any dimension exceeding 8 inches, or other unsuitable material per Section 31 00 00 - Earthwork.

2. Material with excessive or deficient moisture content will not be considered as unsuitable if the moisture content can be adjusted to a level that allows obtaining compaction.

3. Imported backfill material shall conform to imported trench backfill (8" Pit Run) per Section 31 00 00 - Earthwork.

2.3 FOUNDATION STABILIZATION

A. Trench foundation material shall consist of foundation stabilization backfill material per Section 31 00 00 - Earthwork.

2.4 IDENTIFICATION TAPE AND LOCATING WIRE

A. Locating wire shall be No. 12 AWG insulated cooper locating wire with 1/64" PVC insulation.

B. Identification tape shall be 3-inches wide, 4 mil polyethylene vinyl. Tape text and color shall meet the following requirements

Pipe Contents	Text	Color
Potable Water	"CAUTION – WATER LINE BURIED BELOW"	Blue
Pressure Sewer	"CAUTION – SEWER LINE BURIED BELOW"	Green
Reclaimed Water	"CAUTION – RECLAIMED WATER LINE BURIED BELOW"	Purple
Pressure Irrigation	"CAUTION – IRRIGATION LINE BURIED BELOW"	Purple
Gas	"CAUTION – GAS LINE BURIED BELOW"	Yellow
Telephone	"CAUTION – PIPE LINE BURIED BELOW"	Yellow
Cable TV	"CAUTION – PIPE LINE BURIED BELOW"	Yellow
Electric	"CAUTION – ELECTRICAL LINE BURIED BELOW"	Red

PART 3 - EXECUTION

3.1 EXISTING UTILITIES:

A. The Contractor shall be fully responsible for any and all damage to existing or constructed utilities, and shall repair damages in accordance with utility owner's requirements at no additional cost to the Owner. It shall be the Contractor's responsibility to coordinate and notify all affected utility owners. Call 811 Dig-Line before commencing construction.

1. Parallel Utility Support: Work associated with parallel utility support and utility crossings shall be incidental to the work unless a specific bid items is provided for parallel utility support.

2. Utility Crossing Support: All utilities that interfere with the construction of the trenching and pipe installation shall be temporarily supported in accordance with the utility owner's requirements. Work associated with utility crossings support shall be incidental to the work unless a specific bid items is provided for utility crossing support.

3. All crossing utilities shown on the plans and marked by Dig-Line shall be vertical and horizontally located, in a non-destructive manner, prior to construction to verify pipe elevation, materials, and diameter. This information shall be provided to the Engineer for evaluation of conflicts prior to construction. All potholes shall be backfilled immediately after obtaining information.

3.2 TRENCH EXCAVATION

A. Trenches shall be excavated to lines and grades shown on the drawings, with a minimum width at the top or crown of the pipe not to exceed the outside diameter of the pipe plus 2'. In the event the Contractor should over excavate in width or depth without the Engineer's approval, he shall provide pipe bedding for the full length of the over excavation. No special payment will be made for work caused by over excavation.

B. Trench shall be kept free from water at all times to facilitate fine grading, proper laying and joining of pipe, and prevention of damage to completed joints.

C. If the trench bottom is disturbed during excavation, compact trench bottom to 95% maximum density of the standard proctor, ASTM D698.

D. The Contractor shall conduct trench operations in such a manner as to provide adequate safety precautions for workmen, adjacent property, or the public at all times by use of adequate sheeting, shoring, or bracing to sustain stability of the trench floor and walls. The Contractor shall furnish, place, and maintain such shoring as may be required to support sides of the trench. Costs of shoring and bracing shall be considered incidental to trench excavation and backfill.

E. The Contractor shall conduct trench operations in such a manner as to provide adequate safety precautions for workmen, adjacent property, or the public at all times by use of adequate sheeting, shoring, or bracing to sustain stability of the trench floor and walls. The Contractor shall furnish, place, and maintain such shoring as may be required to support sides of the trench.

3.3 PIPE BEDDING

A. Place bedding in layers no thicker than 6 inches. Allow for bedding depth around pipe bells. Place bedding at least 4 inches below the pipe and 6 inches above the pipe.

B. Shovel slice and tamp to ensure that the bedding material is firmly placed.

C. Following placement of pipe, place additional bedding material up to the springline of the pipe. Shovel slice and tamp to ensure that the bedding material fills in and supports the pipe haunch area.

D. In 6 inch lifts, place additional bedding layers from the pipe springline to 6 inches above the pipe.

3.4 TRENCH BACKFILL

A. All backfill material shall be placed in layers not to exceed 8-inch maximum loose lift thickness for native material and 12-inch maximum loose lift thickness for imported aggregate backfill.

B. The entire trench shall be compacted to 95% maximum density of the standard proctor as determined by ASTM D-698.

C. Trenches under buildings and structures shall be compacted, the entire depth, to 95% maximum density of the modified proctor determined by ASTM D1557.

3.5 IDENTIFICATION TAPE AND LOCATING WIRE PLACEMENT

A. Unless indicated otherwise, attach locating wire to the crown of all buried pipelines using electrical tape, except gravity irrigation, sanitary sewer, or storm sewer mains having visible manholes or clean-out structures at all angle points. Provide 12” of slack wire above ground at each location of valve or wire box.

B. Unless indicated otherwise, identification tape shall be placed above all buried pipelines, 18” - 24” above the crown of the pipe, except gravity irrigation, sanitary sewer, or storm sewer mains having visible manholes or clean-out structures at all angle points.

C. Unless indicated otherwise, identification tape shall be placed above all buried pipelines that are installed with locating wire. Identification tape shall be placed 18” - 24” above the crown of the pipe.

3.6 QUALITY CONTROL

A. Material & Compaction Testing: All materials testing of samples will be performed by a testing agency Contracted by the Owner. The Contractor is responsible for coordination with the Owner's testing professional. If tests indicate work does not meet specific compaction requirements, remove work, replace, and retest at the Contractor's expense.

1. Qualifications of testing company

a. Basic requirements of ASTM E 329, "Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials as Used in Construction" and ASTM D 3666, "Standard Specification for Minimum Requirements for Agency Testing and Inspecting Bituminous Paving Materials", as applicable.

b. Calibrate testing equipment at reasonable intervals by devices of accuracy traceable to either the National Bureau of Standards or accepted values of natural physical constants.

2. Frequency of Compaction Tests

a. Test section shall be a test at 2-feet above top of pipe and every 1-foot lift thereafter and at the top of the trench backfill.

b. Two (2) test sections, at different locations for every trench less than 300 feet in length, but not less than once per day.

c. One (1) test section per every 300 feet of additional trench and at locations where materials or construction procedures change, but not less than once per day.

3.7 CLEANUP

A. Surplus excavated material or stripped material not salvaged as topsoil and excavated material not meeting the requirements for backfill shall become waste. All waste material shall be disposed of by the Contractor.

END OF SECTION

SECTION 32 12 16

ASPHALT PAVING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide all labor, equipment and materials as required to provide new pavement, and to repair existing asphalt surfaced, streets, roads, driveways, or other similar improved areas damaged or removed by excavations.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.

B. Superpave Hot Mix Asphalt: Submit job mix formula and ITD approval letter of previously approved Mix Design. Prepare a submittal that includes:

1. The original approved mix design that includes the confirmed JMF from the previous project;

2. adjustments made to the JMF that make it the C-JMF;

3. adjustments made to the C-JMF during production;

4. documentation supporting these adjustments.

5. Current Stockpile Quality Control testing that includes the following to confirm the material in stockpile is similar to the material used for the original mix design, including RAP:

a. Sieve analysis on the stockpiles to be used, including crusher control charts;

6. Note: Previously used mix designs that are used during the calendar year of confirmation may omit Step 5 if the stockpiles consist of the crushed material, including RAP, from the original mix design. Previously used mix designs that more than one calendar year has elapsed from the time of confirmation must include Step 5.

7. JMF with a content of more than 30% recycle asphalt pavement (rap) will not be accepted, regardless of prior ITD approval.

C. Material Test Reports: For each paving material.

1.3 QUALITY CONTROL

A. Testing Agency Qualifications: Qualified according to ASTM D3666 for testing indicated.

B. Pre-Paving Conference: Conduct conference at Project Site. Immediately before paving, the Contractor, the asphalt supplier, the Engineer, and the Owner personnel involved in the paving operation will hold a pre-paving conference to discuss the means that will achieve the highest quality surface.

1. Before the pre-paving conference, submit a Superpave HMA paving plan to the Engineer. Tailor the plan to the asphalt to be supplied, the anticipated JMF, and the Contractor's equipment and operation. Include at least the following:

a. Breakdown, intermediate, and finish rollers to be used

b. Static or vibratory rolling for breakdown and intermediate rolling

c. Frequency, amplitude, force/impact, and roller velocity for vibratory rolling

d. Proximity of breakdown roller to paver with respect to horizontal displacement

e. Proximity of intermediate roller to breakdown roller

f. Compaction temperatures for breakdown, intermediate, and finish rolling

g. Adjustments to paving/compaction operation with respect to temperature, amplitude, frequency, lift thickness, gradation, force/impact, and roller velocity

h. Rubber tired rolling with respect to pickup of pavement material

i. Paving equipment and preheating and vibratory settings of the screed

j. Coordination of plant production and paving operations; climate, haul distance

k. Surface and air temperatures anticipated during production

l. Temperature necessary to allow public traffic onto the new pavement surface

m. Anticipated traffic control issues as necessary

n. Additional equipment required

o. Inspection, sampling and testing requirements

p. Other paving issues as necessary

PART 2 - PRODUCTS

2.1 PLANT MIX PAVEMENT

A. General: Superpave hot mix asphalt shall conform to the 2012 Idaho Department of Transportation Standard Specifications for Highway Construction, Section 405.

1. Mixture Type: SP3

2. Grade of Asphalt: PG 64-28

3. Aggregate Size: 1/2”

4. Anti-Stripping Additive: Provide anti-stripping additive if the immersion compression retained strength (ASTM T165) of the design mix is less than 70 percent of the dry compressive strength. Anti-stripping additive shall be added at the refinery at a rate of 0.5 to 1.0 percent of asphalt cement as determined by laboratory test.

2.2 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations.

B. Coarse Aggregate: ASTM D 692, sound; angular crushed stone, or crushed gravel.

C. Fine Aggregate: ASTM D 1073, sharp-edged natural sand or sand prepared from stone, gravel, or combinations thereof.

1. For plant mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.

D. Mineral Filler: ASTM D 242, rock or slag dust, hydraulic cement, or other inert material.

2.3 AUXILIARY MATERIALS

A. Tack Coat: ASTM D 977 emulsified asphalt, or ASTM D 2397 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

PART 3 - EXECUTION

3.1 GENERAL

A. Do not place pavement on a wet or frozen surface or when weather or surface conditions will otherwise prevent the proper handling or finishing of the pavement placement.

B. Air and Surface Temperature Limitations:

Compacted Thickness of Individual Courses	Top Course	Leveling and Courses Below the Top Course
Less than 1.5”	60°F	-
1.5” to 3”	50°F	40°F
Greater than 3”	40°F	40°F

C. Asphalt concrete shall not be placed when the surface and atmospheric temperature is below 40 degrees F, if rain is imminent or expected before time required for adequate cure, or if subgrade is wet or excessively damp.

3.2 SURFACE PREPARATION

A. Aggregate base shall be provided where indicated to the thickness indicated. The compacted surface of the finished aggregate shall be hard, uniform, smooth and at any point shall not vary more than 0.02 feet from the indicated grade or cross-section.

B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.

2. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.

3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Engineer, and replace with compacted backfill or fill as directed at no cost to the Owner.

C. Proceed with paving only after unsatisfactory conditions have been corrected.

D. Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Verify that subgrade is dry and in suitable condition to begin paving.

E. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, plant mix asphalt paving at a rate of 0.05 to 0.15 gal./sq. yd.

1. Allow tack coat to cure undisturbed before applying plant mix asphalt paving.

2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.3 PATCHING

A. Plant Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches minimum into adjacent sound pavement. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Patching: Fill excavated pavements with plant mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

3.4 SUPERPAVE HOT MIX ASPHALT PAVING

A. Machine place Hot Mix Asphalt on prepared surface, spread uniformly, and strike off. Place Hot Mix Asphalt by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Place Hot Mix Asphalt base course in number of lifts and thicknesses indicated.

2. Place Hot Mix Asphalt surface course in single lift.

3. Spread mix at minimum temperature of 250 deg F (121 deg C).

4. Begin applying Hot Mix Asphalt along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.

5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place Hot Mix Asphalt in consecutive strips not less than 10 feet (3 m) wide unless infill edge strips of a lesser width are required.

1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt base course before placing asphalt surface course.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with plant mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.5 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of Hot Mix Asphalt courses.

1. Clean contact surfaces and apply tack coat to joints.

2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.

3. Offset transverse joints, in successive courses, a minimum of 24 inches.

4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method.

5. Compact joints as soon as Hot Mix Asphalt will bear roller weight without excessive displacement.

6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.6 COMPACTION

A. General: Begin compaction as soon as placed plant mix paving will bear roller weight without excessive displacement. Compact plant mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

1. Do not operate vibratory rollers in the vibratory mode when the internal mix temperature is less than 175 °F or when checking or cracking of the mat occurs at a higher temperature.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while plant mix asphalt is still hot enough to achieve specified density. Continue rolling until plant mix asphalt course has been uniformly compacted to the following density:

1. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while plant mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, plant mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.7 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Surface Course: Plus 1/4 inch, no minus.

B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Surface Course: 1/8 inch.

2. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

C. Corrective Actions:

1. Grind the asphalt pavement to within the surface smoothness tolerance, if thickness permits in accordance with the above criteria.

2. All grinding shall be done parallel to centerline. Adjacent grinder passes within any single ground area shall be extended to produce a neat rectangular area having a uniform surface appearance. At transverse boundaries between ground and unground areas, smoothly feathered transitions shall be made.

3. The Contractor shall check the pavement for smoothness after grinding, in accordance with this specifications and shall make any additional corrections necessary to the pavement to achieve smoothness.

4. After grinding has been completed, the ground pavement surface shall receive a fog coat at a rate approved by the Engineer.

5. The cost of such grinding or milling, and all related work such as fog coat, disposal of milled material, traffic control, flagging, profiling, surface repair of ground or milled areas, and temporary pavement markings shall be at the Contactor's expense.

6. If correction of the pavement as listed above will not produce satisfactory results as to smoothness, or will reduce pavement thicknesses and serviceability excessively, the pavement shall be removed and replaced or overlaid to correct the deficiency at no additional cost to the project.

3.8 FIELD QUALITY CONTROL & ACCEPTANCE

A. Thickness: The Owner's materials testing agency shall extract core samples from the in-place compacted plant mix pavement. Thickness will be determined according to ASTM D 3549.

1. Take two samples minimum. Take one core samples for every 3,500 square feet, at least one sample every day.

2. Tolerance: Plus 1/4 inch (6 mm), no minus.

3. If more than 25% of pavement core samples fail to meet thickness requirements with a tolerance of 0-1/4" minus of the project requirements, or if more than 10% fail to meet thickness requirements with a thickness deficit greater than 1/4", corrective actions shall be taken at no additional cost to the Owner.

4. Corrective Actions:

a. Install 1.5-inch asphalt overlay with same Job Mix Formula and Plant Mix Pavement, if grades allow, or

b. Remove and replace pavement to specified thickness, grades, and smoothness.

c. If allowed by the Engineer, adjusts price for asphalt pavement that does not meet thickness requirements in accordance with the following pay factor (PF) reductions:

1) If thickness is ≥ 100% of Required Thickness, PF = 1.0.

2) If thickness is 1/4" less than the Require Thickness, PF = 0.80.

3) If thickness is 1/2" less than the Require Thickness, subject to rejection, if allowed to remain in place, the PF will be 0.75.

5. Core Samples during Pavement Placement: If cores are taken during placement of pavement, fill core sample holes with hot mix asphalt.

6. Core Samples after Pavement Placement: If cores are taken after placement of pavement, fill core sample hole with 4,000 psi concrete. Prevent concrete from staining asphalt pavement by using a plastic sheet around the core hole while filling with concrete. Tap plastic sheet down.

B. The relative density after compaction shall be 92-96 percent of the density obtained by using ASTM D 1188 or D 2726. A properly calibrated nuclear asphalt testing device shall be used for determining the field density of compacted asphalt concrete, or slabs or cores may be laboratory tested in accordance with ASTM D 1188.

3.9 CLEAN-UP

A. After Work of this Section is complete, remove all debris, rocks, gravel, excess asphalt.

END OF SECTION

SECTION 32 13 13

CONCRETE FOR EXTERIOR IMPROVEMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Furnish all labor, materials, and equipment required for concrete work including forming, reinforcing steel, anchor bolts and site concrete.

1.2 JOB CONDITIONS

A. In hot and cold weather, comply with the requirements of ACI 305 and 306.

B. Do not place concrete on frozen ground. Unless adequate protection is provided, do not place concrete during rain, sleet, or snow.

C. Do not allow rain water to increase mixing water or damage surface finish.

D. When temperature of surrounding air is expected to be below 40°F, during placing, or within 24 hours thereafter, do not allow concrete temperature to drop below 55°F, for sections less than twelve inches (12”) in any dimension, or 55°F, for any other sections.

1. Keep the temperature of concrete, when placed, under 80°F, to preclude loss of slump, flash set, or cold joints.

2. When temperature of steel is greater than 120°F, spray steel forms and reinforcement with water just prior to placing concrete. Do not allow any water to pond in forms.

1.3 SUBMITTALS

A. Submit mix design to be used for each class of concrete.

B. Submit location of materials source, admixtures to be used, and other related data.

C. Submit test reports showing suitability of aggregates used in concrete mixes.

D. Indicate sizes, spacing, locations of reinforcing steel, wire fabric, bending and cutting schedules, splicing, stirrup spacing, supporting, and spacing devices.

E. The Contractor shall pay any material testing expenses associated with material submittals.

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS

A. Portland Cement: Use Portland cement conforming to the requirements of ASTM C 150 Type II for low alkali cement.

B. General Admixtures: Admixtures, other than air-entraining agents, may be used when the type and amount to be used are approved. Calcium chloride will not be allowed as an admixture.

C. Air-Entraining Agents: Use air-entraining agents conforming to the requirements of ASTM C 260. Air entraining admixtures shall be added to the mixing water.

D. Water Reducing Agents: Water reducing admixtures may be used to increase workability of the concrete when approved by the Engineer. Use water reducing admixtures conforming to ASTM C 494.

E. Water: Use potable water for mixing concrete.

F. Coarse Aggregate: Use coarse aggregate that consists of gravel, crushed slag, crushed stone or other approved inert materials, composed of hard, strong and durable particles, free of injurious coatings, and conforming to the requirements of ASTM C 33, except as modified herein.

1. Use only aggregates that include deleterious substances not exceeding the following:

	Percent (by weight)
Soft Fragments	0.20
Coal and Lignite	0.30
Clay Lumps	.30
Other Deleterious Substances	2.0
Minus 200 Material	1.75

2. Use coarse aggregate meeting the following gradations when tested in accordance to the requirements of ASTM C 136.

	Percent Passing (by weight)				
Course Aggregate Size	1"	3/4”	3/8"	No. 4	No. 8
3/4” to No. 4	100	90-100	20-55	1-10	0-5

G. Fine Aggregate: Use aggregate of natural sand or other approved inert materials composed of hard, strong, and durable particles conforming to the requirements of ASTM C 33 except as modified herein.

1. Use only aggregates that include deleterious substances not exceeding the following:

	Percent (by weight)
Clay Lumps	.50
Coal and Lignite	.30
Other Deleterious Substances	2.00
Minus 200 Material	1.75

2. Moisture content of fine aggregate shall not exceed 8 percent.

3. Use fine aggregate that is uniformly graded from coarse to fine within the following gradation, when tested in accordance to the requirements of ASTM C 136.

Sieve Size	Percent Passing (by weight)
3/8"	100
No. 4	95 100
No. 8	80 100
No. 16	50 85
No. 30	25 60
No. 50	10 30
No. 100	2 10

H. Patch Mortar: Make patching mortar using portland cement and sand to form a workable mortar suitable for filling defects in concrete surfaces.

1. Mortar: 1 part portland cement to 2 parts sand by damp loose volume.

2. Mix white and gray portland cement as required to match surrounding concrete.

3. Keep mixing water to a minimum.

4. Mix patching mortar in advance and allow to stand with frequent manipulation, without addition of water, until it has reached stiffest placeable consistency.

I. Curing Compounds: Use curing compounds that meet the requirements of ASTM C 309.

J. Sealer: Use Conspec Silane 40 or approved equal.

K. Joint Sealant: Use Sikaflex 1c SL or approved equal. Use Sonolastic Polysulfide Sealant or approved equal for submerged in water applications. Color to match that of concrete.

2.2 REINFORCING STEEL AND WELDED WIRE MESH

A. Reinforcement Steel: ASTM A 615 Grade 60

B. Welded Wire Fabric: 12x12 W5.4/5.4

2.3 FORMING MATERIALS

A. Smooth Forms: Faced with material which will produce smooth, hard, uniform texture on concrete.

B. Form accessories that are to be partially or wholly embedded in concrete are to be a commercially manufactured type:

1. Use form ties constructed so that ends or end fasteners can be removed without causing appreciable spalling of concrete faces.

C. Form Release Agent: Colorless material which will not stain concrete, absorb moisture, or impair natural bonding or color characteristics of coating intended for use on concrete.

D. Contraction Joint Material: Wood strips; maximum possible length.

E. Dobie Blocks: Commercial grade blocks to support horizontal reinforcement.

2.4 READY MIX CONCRETE

A. Furnish commercial ready mix shall have the following properties:

Construction Type	Minimum Compressive Strength	Minimum Cement Content	Maximum Water / Cement Ratio	Air Entrainment Percentage	Maximum Slump
Light Pole, Sign, Fence Foundations	3,000 psi	560 LB/CY	0.49	6.5 ±1.5	4 ±1
Curbs, Gutters	4,000 psi	560 LB/CY	0.44	6.5 ±1.5	2.5 ±1

Construction Type	Minimum Compressive Strength	Minimum Cement Content	Maximum Water / Cement Ratio	Air Entrainment Percentage	Maximum Slump
Concrete Pavement	4,000 psi	560 LB/CY	0.44	6.5 ±1.5	4 ±1
Walking Surfaces – Sidewalks, Patios, Driveways, Stairs	4,500 psi	564 LB/CY	0.44	6.5 ±1.5	4 ±1

B. Fly ash may be used to replace a portion of the Portland cement in the concrete mix. The fly ash used shall not exceed twenty five percent of the total cement material in the mix. The cement material in the mix includes both Portland cement and fly ash. Fly Ash shall be Class F conforming to AASHTO M 295 with the additional requirement that the available alkalies in the fly ash shall not exceed 2 percent.

C. Ready-mixed concrete shall conform to the provisions in ASTM C 94 regarding batching, mixers and agitators, mixing and delivery, inspection, consistency and air content, and certification of batches.

2.5 TRUNCATED DOMES

A. Detectable warning domes shall be pre-manufactured units integrally cast into concrete ramp. The detectable warning surface shall be removable. Use Replaceable Wet-Set, manufactured by ADA Solutions, or approved equal.

B. Color shall be Federal Yellow.

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor shall not incorporate ready mix concrete into the work that does not meet these specifications. The ready mix concrete that is in non-compliance shall be removed from the project.

3.2 FORMING

A. Make forms sufficiently tight to prevent loss of cement paste. Arrange facing material orderly and symmetrical, keeping number of seams to a practical minimum.

B. Place chamfer strips in corners of forms to produce beveled edges on permanently exposed surfaces.

C. To maintain specified finish tolerances, chamfer formwork to compensate for anticipated deflections.

D. Provide positive means of adjustment using wedges or jacks, or shores and struts, and take up all settlement during concrete placing operation.

E. Securely brace forms against lateral deflection.

F. Provide temporary ports in formwork to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain. Close ports with tight fitting panels, flush with inside face of forms, neatly fitted so that joints will not be apparent in exposed concrete surfaces.

G. At construction joints, overlap forms over hardened concrete at least six inches (6"). Hold forms against hardened concrete to prevent offsets or loss of mortar at construction joint and to maintain true surface.

H. Anchor formwork to shores or other supporting surfaces or members so that upward or lateral movement of any part of formwork system is prevented during concrete placement.

I. Anchor formwork to shores or other supporting surfaces or members so that upward or lateral movement of any part of formwork system is prevented during concrete placement.

J. Position expansion joint material and other embedded items accurately and support against displacement.

3.3 REINFORCING

A. Place all reinforcement in the exact position shown on the plans and approved shop drawings and secure in position during the placing and compacting of concrete. Wire bars together with No. 16 gage wire with ties at all intersections except where spacing is less than 12 inches in each direction, in which case tie alternate intersections.

B. Place dobie blocks to maintain clearance from subgrade.

3.4 INSERTS, EMBEDDED PARTS, AND OPENINGS

A. Coordinate work of other sections in forming and setting openings, slots, recesses, chases, sleeves, bolts, anchors, and other inserts.

B. Install accessories in accordance with manufacturer's instructions, level and plumb with templates where necessary. Ensure items are not disturbed during concrete placement.

3.5 CONVEYING CONCRETE MIX

A. Unless specifically approved by the Engineer prior to placement of ready mix concrete, all concrete mix shall be placed and discharged completely within 90 minutes of the introduction of water into the mix or before the drum has been revolved 300 revolutions, whichever comes first.

B. Handle concrete from mixer to location of final placing as rapidly as practicable by methods which prevent segregation or loss of ingredients, and assure that quality is maintained.

C. Use only equipment conforming to ASTM C 94.

D. Use only approved pumping equipment that is rated for the lift and the capacity required for placement.

1. Control pneumatic placement to prevent segregation.

2. Loss of slump in pumping or pneumatic conveying equipment shall not exceed two inches (2”).

3. Do not use aluminum or aluminum alloy pipes.

3.6 TRUNCATED DOMES

A. Place truncated domes in fresh concrete in accordance with manufacture’s recommendations.

3.7 CONTROL JOINTS

A. For flatwork, place control (contraction) joints of the type indicated in the plans prior to concrete curing.

B. Install joints spaced no more than 24 times the slap thickness (i.e. a 4-inch thick slab shall have a control joint at least every 96-inches = 8-feet). Contraction joints should be placed to produce panels that are as square as possible and never exceeding a length to width ratio of 1 ½ to 1

C. Joint depth shall be at least 25% of slab depth.

D. Tooled joints shall be installed using a grooving tool. Contraction joints may be tooled into the concrete surface at the time of placement. Joints may be tooled into the surface (first pass) prior to the onset of bleeding or immediately with the first pass of the floating operation.

E. Sawcut joints between 6-12 hours after finishing concrete, unless specifically approved otherwise by the engineer. Sawcut as soon as the concrete is hard enough to withstand the energy of sawing without raveling or dislodging aggregate particles, and that the edges abutting the cut do not chip from the saw blade.

3.8 REMOVAL OF FORMS

A. Formwork for columns, walls, and other parts not supporting weight of concrete may be removed as soon as concrete has hardened sufficiently to resist damage from removal.

3.9 FINISHES

A. Provide formed concrete walls to be left exposed with Sacked Finish.

1. Point and Patch: Patch defects, chip or rub off fins exceeding one-quarter inch (1/4) in height with Patch Mortar. Patch tie holes and defects and remove fins completely. When surface texture is impaired and form joints misaligned by more than one-eighth (1/8) inch, grind or bushhammer.

2. Sacked Finish: Remove forms and perform necessary patching as soon after placement as possible. Finish newly hardened concrete no later than the day following form removal. Wet surfaces and rub with carborundum brick or other abrasive until uniform color and texture are produced. No cement grout to be used other than cement paste drawn from concrete by rubbing process.

B. Concrete flatwork shall not be trowelled, use screed, float, and broom.

C. Stairs to receive a light broom finish parallel to the nose of the tread. And shall receive nose end treatment as shown in the plans.

D. Sidewalks to receive a light broom finish perpendicular to the direction of travel.

E. Patios to receive light broom finish.

F. Curbs and Gutter to receive light broom finish parallel to flow line of gutter.

G. Pedestrian ramps to receive a light broom finish perpendicular to the direction of travel.

H. Light pole, sign, fence foundations to receive light broom finish.

3.10 CURING AND PROTECTION

A. To preserve moisture in unformed concrete surfaces, apply one of the following immediately after placement and finishing.

1. Continuous mist spray.

2. Waterproof sheet materials, ASTM C 171.

3. Curing compound, ASTM C 309. Apply in accordance with recommendations of manufacturer immediately after water sheen has disappeared. Do not use on any surface against which additional concrete or other material is to be bonded or adhesively applied, unless it is proven that curing compound will not prevent bond, or unless positive measures are taken to remove it completely from areas to receive bonded applications. Provide curing compound compatible with hardener in areas where hardener is to be used.

B. Cure concrete for seven (7) days.

C. When mean daily outdoor temperature is less than 40°F, maintain temperature of concrete between 50°F and 70°F for required curing period.

3.11 SEALER

A. Apply sealer to vertical walls, stairs, and walkways. Apply two coats. Apply in accordance with manufactures recommendations.

3.12 TESTING

A. Material & Compaction Testing: All materials testing of samples will be performed by a testing agency Contracted by the Owner. The Contractor is responsible for coordination with the Owner's testing professional.

B. Perform the following testing:

1. Entrained Air – Test every 30 yards of concrete delivered to the project.

2. Slump – Test every 30 yards of concrete delivered to the project.

3. Strength characteristics – Test every 30 yards of concrete placement with four compressive test cylinders.

4. Temperature: If air temperature is less than 40°F, test every 30 yards of concrete delivered.

C. Test results shall be reported in writing to the Engineer within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

D. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

3.13 ACCEPTANCE

A. The Engineer will base acceptance of the concrete on parameters specified for the given concrete class. The Engineer will base acceptance of strength from the results of 28-day compression strength test results on cylinders made from concrete being placed. The engineer will consider average strength from three companion cylinders as one test.

B. Replace unacceptable concrete at no additional cost to the Owner.

C. The Engineer will use a price adjustment for concrete that does not meet the intended strength, but is allowed to remain in place by the Engineer, in accordance with the following pay factor (PF) reductions:

1. If compression strength is ≥ 100% of required, PF = 1.0.

2. If compression strength is ≥ 95% < 100% of required, PF = 0.90.

3. If compression strength is ≥ 90% < 95% of required, PF = 0.80.

4. If compression strength is < 90% of required, subject to rejection, if allowed to remain in place, the PF will be 0.50.

3.14 SPECIAL WARRANTY

A. Scaled or spalled surfaces exceeding 5% (randomly dispersed or concentrated) per twenty (20) square feet of concrete surfacing area will be considered defective and shall be replaced at the Contractor's expense. The area requiring replacement will be as directed by the Engineer.

END OF SECTION

SECTION 32 17 23

PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Pavement marking materials and installation.

1.2 SUBMITTALS

A. Submit manufacturer's certification that paint meets or exceeds specified requirements.

1.3 STORAGE AND HANDLING

A. Store paint in an area prepared to contain spills and prevent contamination of storm water.

PART 2 - MATERIALS

2.1 PAVEMENT PAINT (WATERBORNE)

A. Paint to be waterborne with volatile organic compound (VOC) less than 150 g/L.

B. Paint to conform to either the current Idaho Waterborne Traffic Line Paint Specifications or to Federal Specification TT-P-1952-D with the following modifications:

1. Viscosity: 80-95 K.U. per ASTM D 562.

2. Total Nonvolatile Solids: 75% minimum per ASTM D 2369.

3. Scrub Resistance: 1,000 cycles minimum per ASTM D 2486.

4. pH: 9.6 S.U. minimum per (ASTM E 70).

C. Paint Colors: Meet the Federal Test Standard 595 with color chip designations:

1. White: 37875.

2. Yellow: 33538.

3. Blue: OSHA Handicap Blue

a. E 303.

2.2 SOURCE QUALITY CONTROL

A. Provide test and inspection reports required of the Manufacturer.

B. Inspect material shipping lists to verify type, class, thickness and marking information required by the Standard for paint and thermoplastic markings.

PART 3 - EXECUTION

3.1 EQUIPMENT

A. Airless spray-type marking equipment, compatible with waterborne paint, and capable of providing a uniform wet film thickness of 15 ± 2 mils.

3.2 EXAMINATIONS

A. Verify that pavement preparation work is complete prior to painting operations.

B. Verify paint delivered to the site meet the requirements of the Contract Documents.

C. Verify pavement has had cure time exceeding 7 days.

3.3 PAINT APPLICATION

A. Pavement surface must be clean and thoroughly dry.

B. Ambient air temperature must be above 50°F.

C. Paint stripes to be uniform and free of erratic waves.

D. Width and location of marking to be as designated in the drawings and be within a tolerance of 5%.

E. Paint stripes must not deviate from the intended alignment by more than 2 inches in 100 feet.

F. Apply paint in accordance with the manufacturer's recommendations.

G. Apply painted pavement markings (school crosswalk text, RR crossings, turn arrows, etc.) using an approved template.

H. Mix paint thoroughly prior to application.

I. Do not thin paint.

J. Apply paint at a rate of not more than 100 square feet/gallon.

K.

L. All pavement markings to conform to the MUTCD.

M. If paint is unagitated for a period greater than 15 minutes, thoroughly agitate until the mixture is homogeneous prior to continuance of application.

END OF SECTION

SECTION 32 31 13

CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. The Contractor shall provide chain link fencing and slide gates and appurtenant Work, complete and operable.

1.2 SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Shop drawings of fences and gates with all dimensions, details, and finishes. Drawings must include post foundations.

C. Product data: Manufacturer’s catalog indicating materials and a letter certifying that all conditions of the specifications have been met.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Chain link fencing and gates shall be products of a single manufacturer which has been successfully engaged in the production of such items for a period of at least 5 years.

B. Installer's Qualifications: Installation of the chain link fence shall be by the manufacturer or by a firm accepted and licensed by the manufacturer.

PART 2 - MATERIALS

2.1 GENERAL

A. All perimeter fencing and gates shall be 6 feet high. All materials and components shall be new, first quality items specifically manufactured for the intended application.

2.2 CHAIN LINK FENCE FABRIC

A. Chain link fence fabric shall be made of steel wire helically wound and interwoven in such a manner as to provide a continuous mesh without knots or ties except in the form of knuckling or twisting the ends of the wire to form the desired selvage of the fabric.

B. Fence fabric shall be No. 11 gauge steel wire, 2-inch mesh, with top selvages knuckled and bottom selvages twisted and barbed. Fabric shall be galvanized in conformance with ASTM A392, Class 1, with not less than 1.2 ounces zinc per square foot of coated surface.

2.3 STEEL FENCE FRAME MEMBERS

A. Steel pipe produced in accordance with commercial standards. Minimum yield strength of 50,000 psi. Cold formed and welded per ASTM F1043 Group IC. Pipe sections to conform to ASTM A120, Schedule 40 standard weights.

B. Pipe Section Size

1. End and Corner Post 2-3/8” OD, 3.65 lb/ft

2. Line 1.9” OD, 2.72 lb/ft

3. Rail and Braces 1.66” OD, 2.27 lb/ft.

4. Gate Post 6-5/8” OD

2.4 FITTINGS

A. Chain link fence fittings per ASTM F 626. All ferrous metal fittings to be galvanized.

B. Post caps: Steel, cast iron or aluminum alloy; must be weatherproof to prevent moisture intrusion into post. Top with arm to be provided when barbed wire is specified or intermediate or line post tops to have loop for top rail when only rail is specified.

C. Rail ends: Formed steel or iron, designed to provide secure connection of top rails to terminal post and brace or other rails to terminal and intermediate posts.

D. Sleeves: Lengths of top rails to be connected using 6" sleeves with a .055 minimum wall thickness that allow for expansion or contraction of the rail.

E. Tie Wire: 9 gauge galvanized steel or aluminum for attachment of chain link fabric to rails. Hog rings attach fabric to tension wire to be 12-1/2 GA steel.

F. Fabric bands and brace bands to be pressed steel.

G. Tension (stretcher) bars to be made of one continuous piece of steel or aluminum, 3/16" x 3/4", in the same height as the fence. Provide one bar, per end or gate post and two bars per corner or pull post.

H. Tension wire: Galvanized steel wire, 7 gauge core, having a tensile strength of 75,000 psi.

I. Truss rods & tightened. Rod diameter 3/8".

J. Nuts, bolts and screws shall be steel, minimum size 3/8-inch diameter, hot-dip galvanized after fabrication.

K. Barbwire shall be 3-strand, No. 10 gage zinc-coated steel or iron wire with 4-point, 14-gage barbs spaced not more than 5 inches apart.

L. Barbwire extension arms shall be 3-strand, 45°, pressed steel – galvanized, with "Z" cut into barbwire arm. Barbwire arm to have rail and loop cap as one piece.

M. Galvanized coating damaged during construction of the fencing shall be repaired by application of Galvo-Weld; Galvinox; or equal.

2.5 SLIDE GATE

A. Chain link slide gate and fittings per ASTM F626. All ferrous metal fittings to be galvanized.

B. Chain link slide gates as per ASTM F 900 Specifications for Industrial and Commercial Slide Gates.

C. Gate to be equipped with fork latch with pad-lock hole to be pressed steel.

D. Plunger to be hot-dipped galvanized drop rod, 1/2-inch diameter, 30-inches long, with a 4-inch long handle.

2.6 SLIDE GATE

A. Chain link slide gate and fittings per ASTM F626. All ferrous metal fittings to be galvanized.

B. Chain link slide gates as per ASTM F1184 Specifications for Industrial and Commercial Horizontal Slide Gates.

C. Gate to be equipped with latch with pad-lock hole to be pressed steel.

2.7 POST FOUNDATIONS

A. Concrete Class 3000 in accordance with ISPWC Section 703.2.4 Table 1.

PART 3 - EXECUTION

3.1 GENERAL

A. Inspection: Prior to commencing installation, require Installer to inspect all areas and conditions within which Work of this Section will be performed. Dimensions and clearances shall be verified. Final grading shall be completed and all earth, brush, or other obstructions which interfere with the proper alignment and construction of fencing shall be removed.

B. Unless otherwise indicated, all posts shall be set in concrete. Gate and related posts, corner posts, and other critical elements shall be provided with concrete foundations which are designed by an engineer to safely accommodate the loads to which they will be subjected.

3.2 INSTALLATION

A. Excavation: Holes for posts shall be drilled or hand excavated to the diameters and spacing indicated on the plans, in firm, undisturbed or compacted soil. Post foundations shall comply with the following:

B. Holes shall be excavated to a diameter not less than 12-inches or not less than 5 times the largest dimension of the item being anchored, whichever is larger.

C. Depth for holes shall be not less than 40 inches.

D. Setting Posts: Line posts shall be spaced at not more than 10-foot intervals, measured from center to center of the posts, parallel to the ground slope. Posts shall be set plumb and shall be centered in holes, 4-inches above the bottom of the excavation, with posts extending not less than 36-inches below finish grade surface.

E. Corner posts shall be installed where changes in the fence lines equal or exceed 30 degrees, measured horizontally.

F. Each post shall be properly aligned vertically and its top aligned parallel to the ground slope. Posts shall be maintained in proper position during placement and finishing operations.

G. Concrete: Concrete for footings may be placed without forms, providing the ground is firm enough to permit excavation to neat line dimensions. Prior to placing concrete, the earth around the hole shall be thoroughly moistened.

H. Encasement concrete for footings shall be placed immediately after mixing in a manner such that there will be no concentration of the large aggregates. The concrete shall be consolidated by tamping or vibrating.

I. Concrete footings shall have a neat appearance and shall be extended 2-inches above grade and troweled to a crown to shed water.

J. A minimum of 7 days shall elapse after placing the concrete footings before the fence fabric is fastened to the posts.

K. Bracing: Bracing shall be provided at all ends, corners, gates, and intermediate brace posts. Corner posts and intermediate brace posts shall be braced in both directions. Horizontal brace rails shall be set midway between the top rail and the ground, running from the corner, end, intermediate brace or gate post to the first line post. Diagonal tension members shall connect tautly between posts below horizontal braces.

L. Braces shall be so installed that posts remain plumb when diagonal rod is under proper tension.

M. Intermediate Brace Posts: Where straight runs of fencing exceed 500-feet, intermediate brace posts shall be installed, spaced equally between ends or corners; with additional posts provided as required, such that the spacing between intermediate brace posts does not exceed 500-feet. Intermediate brace posts shall be equivalent in size to corner posts and shall be braced with horizontal brace rails and diagonal tension members in both directions.

N. Top Rails: Top rails shall be run continuously through post caps, bending to radius for curved runs. Expansion couplings shall be provided as recommended by the fencing manufacturer.

O. Tension Wire: Continuous bottom tension wire shall be stretched tight with turnbuckles at end, gate, intermediate, and corner posts. Tension wire shall be installed on a straight grade between posts, with approximately 2-inches of space between finish grade and bottom selvage, unless otherwise indicated. Tension wire shall be tied to each post with not less than 6 gauge galvanized wire.

P. Fabric: The chain-link fabric shall be fastened on the secured side of the posts. Fabric shall be stretched and securely fastened to posts. Between posts, top and bottom edges of the fabric shall be fastened to the top rail and bottom tension wire, respectively. Fabric shall be stretched and anchored in such a manner that it remains in tension after the pulling force is released.

Q. Tie Wires: Tie wire shall be bent to conform to the diameter of the pipe to which it is attached, clasping pipe and fabric firmly with ends twisted at least two full turns. Ends of wire shall be bent back to minimize hazard to persons or clothing.

R. Fabric shall be tied to line posts with tie wires spaced at 12-inches on center.

S. Fabric shall be tied to rails and braces with tie wires spaced at 14-inches on center.

T. Fabric shall be tied to tension wires, with hog rings spaced 18-inches on center.

U. Stretcher Bars: Fabric shall be fastened to end, corner, intermediate brace, and gate posts with stretcher bars. Bars shall be threaded through or clamped to fabric at 4-inches on center and secured to posts with stretcher bar bands spaced no more than 14-inches on center.

V. Fasteners: Nuts for tension bands and hardware bolts shall be installed on the side of fence opposite the fabric side. Ends of bolts shall be peened or the threads scored to prevent removal of nuts.

3.3 GROUNDING

A. Fences crossed by power lines of 600 volts or more shall be grounded at or near the point of crossing and at distances not exceeding 150-feet on each side of the crossing.

B. Fences, gates and appurtenances enclosing electrical equipment areas, gas yards, or other hazardous areas shall be electrically continuous and grounded.

C. Ground conductor shall consist of No. 8 AWG solid copper wire. Grounding electrodes shall be 3/4-inch by 10-foot long copper-'clad steel rod. Electrodes shall be driven into the earth so that the top of the electrode is at least 6-inches below grade.

1. Where driving is impracticable, electrodes shall be buried a minimum of 12-inches deep and radically from the fence. Top of electrode shall be not less than 2-feet or more than 8-feet from the fence.

D. Ground conductor shall be clamped to the fence and electrodes with bronze grounding clamps so as to create electrical continuity between fence posts, fence fabric, and ground rods. After installation, the total resistance of fence to ground shall not be greater than 25 ohms.

END OF SECTION

SECTION 32 84 00

PLANTING IRRIGATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Pipes, tubes, and fittings.
2. Manual valves.
3. Automatic control valves.
4. Automatic drain valves.
5. Sprinklers.
6. Quick couplers.
7. Controllers.
8. Boxes for automatic control valves.

1.2 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories of the selected models for the following equipment.
1. Pipes, tubes, and fittings.
2. Manual valves.
3. Automatic control valves.
4. Automatic drain valves.
5. Sprinklers.
6. Quick couplers.
7. Controllers.
8. Boxes for automatic control valves.

B. Wiring Diagrams: For power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Zoning Chart: Indicate each irrigation zone and its control valve.

B. Controller Timing Schedule: Indicate timing settings for each automatic controller zone.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.
1. As specified in Section 01 77 00 – Closeout Procedures
2. As specified in Section 01 78 23 – Operation and Maintenance Data
3. Seasonal activities of start-up, shut-down, and winterization including blowout operation of sprinkler system with compressed air.

4. Backflow preventer, including instructions for testing.
5. Automatic control valves
6. Sprinklers
7. Controllers

B. Record Drawings
1. As specified in Section 01 78 39 – Project Record Documents
2. Drawings shall be present on site during any work and be noted with exact locations of the following items. Items shall be dimensioned from two permanent points of reference.
   a. Point of connection, including any sensor assemblies.
   b. Routing of main line.
   c. Gate valves
   d. Sprinkler control valves
   e. Quick coupling valves
   f. Routing of control wires if different from piping.
   g. Sprinkler heads
   h. Irrigation system

1.5 QUALITY ASSURANCE

A. Inspection and Approval
1. Whenever the word "approve", "approved", or "approval", or "Inspecting Officer" appears herein, it shall mean the approval of the Landscape Architect, the Owner's designated Inspecting Officer, and the Project Architect.

B. Regulatory Requirements
1. Work and Materials: All work installed under Section 32 84 00 shall conform to local, city, county, and state building codes. Nothing in the Contract Documents is to be construed to permit non-conforming work. Should the Contract Documents be at variance with the aforementioned rules and regulations, notify the Inspecting Officer for instructions before proceeding. The most stringent codes at time of bid apply.

C. Permits and Fees: Obtain permits, licenses, pay required fees, and schedule required inspections from agencies having jurisdiction.

D. Utilities Protection
1. The irrigation plan is not a survey of underground utilities. It is the responsibility of the Contractor to have all utilities clearly marked before starting work and to have the markings maintained throughout construction.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Protection of Existing Plants and Site Elements: Protection of remaining site elements, the work of other trades, adjacent properties, easements, and rights-of-way, and all areas outside of the work area identified in the drawings. Damages shall be repaired at the Contractor’s expense.

1.6 WARRANTY

A. Warranty System against defects of materials and workmanship for 12 months from the date of Substantial Completion, including but not limited to:
   1. Filling and repairing depressions and replacing plantings damaged from settlement or repair of irrigation trenches.
   2. Protect equipment from freezing damage.
   3. Repair or replace defective parts.
   4. Promptly repair any damage to property resulting from leaks or defects of materials, equipment, or workmanship at no cost to the Owner and to the satisfaction of the Architect.

B. Make monthly inspections to ensure the system operates properly, through warranty period. Adjust sprinkler heads as required to maintain complete, effective coverage, and to keep spray off structures and pavement throughout warranty period. Irrigation contractors are responsible for one complete seasonal startup and shutdown at no cost to the owner.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Irrigation Zone Control: Automatic operation with controller and automatic control valves.

B. Location of Sprinklers and Specialties: Design location is approximate. Make minor adjustments necessary to avoid plantings and obstructions, such as signs and light standards. Maintain 100 percent irrigation coverage of areas indicated.

C. Minimum Working Pressures: The following are minimum pressure requirements for piping, valves, and specialties unless otherwise indicated:
   1. Irrigation Main Piping: 200 psig.
   2. Circuit Piping: 150 psig.

2.2 PIPES, TUBES, AND FITTINGS

A. Comply with requirements in Irrigation Schedule on Drawings for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

B. Galvanized-Steel Pipe: ASTM A53/A53M, Standard Weight, Type E, Grade B.

   1. Galvanized-Steel Pipe Nipples: ASTM A733, made of ASTM A53/A53M or ASTM A106/A106M, Standard Weight, seamless-steel pipe with threaded ends.
   2. Galvanized, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
   3. Malleable-Iron Unions: ASME B16.39, Class 150, hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface, and female threaded ends.
   4. Cast-Iron Flanges: ASME B16.1, Class 125.

C. Ductile-Iron Pipe with Push-on Joint: AWWA C151, with push-on-joint bell and spigot ends.

1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

    a. Gaskets: AWWA C111 rubber.

D. PE Pipe with Controlled ID: ASTM D2239, PE 3408 compound; SIDR 11.5 and SIDR 15.

1. Insert Fittings for PE Pipe: ASTM D2609, nylon or propylene plastic with barbed ends. Include bands or other fasteners.

E. PVC Pipe: ASTM D1785, PVC 1120 compound, Schedule 40.

1. PVC Socket Fittings: ASTM D2466, Schedule 40.
2. PVC Threaded Fittings: ASTM D2464, Schedule 80.
3. PVC Socket Unions: Construction similar to that of MSS SP-107, except both headpiece and tailpiece shall be PVC with socket ends.

2.3 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick unless otherwise indicated; full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

D. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux in accordance with ASTM B813.

E. Solvent Cements for Joining PVC Piping: ASTM D2564. Include primer in accordance with ASTM F656.

F. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.4 MANUAL VALVES

A. Curb Valves:
1. Description:
    a. Standard: AWWA C800.
    b. NPS 1 and Smaller Pressure Rating: 100 psig minimum.
    c. NPS 1-1/4 to NPS 2 Pressure Rating: 150 psig.
    d. Body Material: Brass or bronze with ball or ground-key plug.
    e. End Connections: Matching piping.
    f. Stem: With wide-tee head.

B. Brass Ball Valves:
1. Manufacturers: Refer to Irrigation Schedule on Drawings.
2. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Forged brass.
f. Ends: Threaded or solder joint if indicated.
g. Seats: PTFE or TFE.
h. Stem: Brass.
i. Ball: Chrome-plated brass.
j. Port: Full or regular, but not reduced.

C. Plastic Ball Valves:
1. Manufacturers: Refer to Irrigation Schedule on Drawings.
2. Description:
a. Standard: MSS SP-122.
b. Pressure Rating: 150 psig.
c. Body Material: PVC.
d. Type: Union.
e. End Connections: Socket or threaded.
f. Port: Full.

2.5 AUTOMATIC CONTROL VALVES

A. Plastic, Automatic Control Valves:
1. Manufacturers: Refer to Irrigation Schedule on Drawings.
2. Description: Molded-plastic body, normally closed, diaphragm type with manual-flow adjustment, and operated by 24 V ac solenoid.

2.6 AUTOMATIC DRAIN VALVES

A. Description: Spring-loaded-ball type of corrosion-resistant construction and designed to open for drainage if line pressure drops below 2-1/2 to 3 psig.

2.7 SPRINKLERS

A. General Requirements: Designed for uniform coverage over entire spray area indicated at available water pressure.

B. Plastic, Pop-up, Gear-Drive Rotary Sprinklers:
1. Manufacturers: Refer to Irrigation Schedule on Drawings.
2. Description:
a. Body Material: ABS.
b. Nozzle: ABS or Brass.
c. Retraction Spring: Stainless steel.
d. Internal Parts: Corrosion resistant.

C. Plastic, Pop-up Spray Sprinklers:
1. Manufacturers: Refer to Irrigation Schedule on Drawings.
2. Description:

a. Body Material: ABS.
b. Nozzle: ABS or Brass.
c. Retraction Spring: Stainless steel.
d. Internal Parts: Corrosion resistant.
e. Pattern: Fixed, with flow adjustment.

2.8 QUICK COUPLERS

A. Manufacturers: Refer to Irrigation Schedule on Drawings.

B. Description: Factory-fabricated, bronze or brass, two-piece assembly. Include coupler water-seal valve; removable upper body with spring-loaded or weighted, rubber-covered cap; hose swivel with ASME B1.20.7, 3/4-11.5NH threads for garden hose on outlet; and operating key.

2.9 CONTROLLERS

A. Manufacturers: Refer to Irrigation Schedule on Drawings.

B. Description:

1. Controller Stations for Automatic Control Valves: Each station is variable from approximately 5 to 60 minutes. Include switch for manual or automatic operation of each station.
2. Interior Control Enclosures: NEMA 250, Type 12, dripproof, with locking cover and two matching keys.
   a. Body Material: Molded plastic.
   b. Mounting: Surface type for wall.
3. Control Transformer: Refer to Irrigation Schedule on Drawings.
4. Timing Device: Adjustable, 24-hour, 14-day clock, with automatic operations to skip operation any day in timer period, to operate every other day, or to operate two or more times daily.
   a. Manual or Semiautomatic Operation: Allows this mode without disturbing preset automatic operation.
   b. Nickel-Cadmium Battery and Trickle Charger: Automatically powers timing device during power outages.
   c. Surge Protection: Metal-oxide-varistor type on each station and primary power.
5. Moisture Sensor: Adjustable from one to seven days, to shut off water flow during rain.
6. Wiring: UL 493, Type UF multiconductor, with solid-copper conductors; insulated cable; suitable for direct burial.
   a. Feeder-Circuit Cables: No. 12 AWG minimum, between building and controllers.
   b. Low-Voltage, Branch-Circuit Cables: No. 14 AWG minimum, between controllers and automatic control valves; color-coded different from feeder-circuit-cable jacket color; with jackets of different colors for multiple-cable installation in same trench.
   c. Splicing Materials: Manufacturer's packaged kit consisting of insulating, spring-type connector or crimped joint and epoxy resin moisture seal; suitable for direct burial.

2.10 BOXES FOR AUTOMATIC CONTROL VALVES

A. Plastic Boxes:
   1. Description: Box and cover, with open bottom and openings for piping; designed for installing flush with grade.
      a. Size: As required for valves and service.
      b. Shape: Round or Rectangular.
      c. Sidewall Material: PE, ABS, or FRP.
      d. Cover Material: PE, ABS, or FRP.

B. Drainage Backfill: Washed gravel or crushed stone, graded from 3 inch minimum to 6 inches maximum.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 31 00 00 "Earthwork"

B. Install warning tape directly above pressure piping, 12 inches below finished grades, except 6 inches below subgrade under pavement and slabs.

C. Drain Pockets: Excavate to sizes indicated. Backfill with washed gravel or crushed stone, graded from 3 inches to 12 inches below grade. Cover gravel or crushed stone with sheet of asphalt-saturated felt and backfill remainder with excavated material.

D. Provide minimum cover over top of underground piping according to the following:
   1. Irrigation Main Piping: Minimum depth of 24 inches below finished grade.
   2. Circuit Piping: 12 inches.
   3. Drain Piping: 12 inches.
   4. Sleeves: 24 inches.

3.2 INSTALLATION OF PIPING

A. Location and Arrangement: Drawings indicate location and arrangement of piping systems. Install piping as indicated unless deviations are approved on Coordination Drawings.

B. Install piping at minimum uniform slope of 0.5 percent down toward drain valves.

C. Install piping free of sags and bends.

D. Install groups of pipes parallel to each other, spaced to permit valve servicing.

E. Install fittings for changes in direction and branch connections.

F. Install unions adjacent to valves and to final connections to other components with NPS 2 or smaller pipe connection.

G. Install flanges adjacent to valves and to final connections to other components with NPS 2-1/2 or larger pipe connection.

H. Install expansion loops in control-valve boxes for plastic piping.

I. Lay piping on solid subbase, uniformly sloped without humps or depressions.

J. Install ductile-iron piping in accordance with AWWA C600.

K. Install PVC piping in dry weather when temperature is above 40 deg F. Allow joints to cure at least 24 hours at temperatures above 40 deg F before testing.

3.3 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Flanged Joints: Select rubber gasket material of size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

E. Ductile-Iron Piping Gasketed Joints: Comply with AWWA C600 and AWWA M41.

F. PE Piping Fastener Joints: Join with insert fittings and bands or fasteners in accordance with piping manufacturer's written instructions.

G. PVC Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:
   1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. PVC Pressure Piping: Join schedule number, ASTM D1785, PVC pipe and PVC socket fittings in accordance with ASTM D2672. Join other-than-schedule-number PVC pipe and socket fittings in accordance with ASTM D2855.
   3. PVC Nonpressure Piping: Join in accordance with ASTM D2855.

3.4 INSTALLATION OF VALVES

A. Underground Curb Valves: Install in curb-valve casings with tops flush with grade.

B. Underground Iron Gate Valves, Resilient Seat: Comply with AWWA C600 and AWWA M44. Install in valve casing with top flush with grade.

1. Install valves and PVC pipe with restrained, gasketed joints.

C. Aboveground Valves: Install as components of connected piping system.

D. Throttling Valves: Install in underground piping in boxes for automatic control valves.

E. Drain Valves: Install in underground piping in boxes for automatic control valves.

3.5 INSTALLATION OF SPRINKLERS

A. Install sprinklers after hydrostatic test is completed.

B. Install sprinklers at manufacturer's recommended heights.

C. Locate part-circle sprinklers to maintain a minimum distance of 4 inches from walls and 2 inches from other boundaries unless otherwise indicated.

3.6 INSTALLATION OF AUTOMATIC IRRIGATION CONTROL SYSTEM

A. Equipment Mounting, Interior: Install controllers on interior wall.
1. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Install control cable in same trench as irrigation piping and at least 2 inches below or beside piping. Provide conductors of size not smaller than recommended by controller manufacturer. Install cable in separate sleeve under paved areas.

3.7 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

B. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplates and signs on each automatic controller.
1. Text: In addition to identifying unit, distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

C. Warning Tapes: Arrange for installation of continuous, underground, detectable warning tapes over underground piping during backfilling of trenches.

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, operate controllers and automatic control valves to confirm proper system operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
4. Irrigation system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.9 ADJUSTING

A. Adjust settings of controllers.

B. Adjust automatic control valves to provide flow rate at rated operating pressure required for each sprinkler circuit.

C. Adjust sprinklers and devices, except those intended to be mounted aboveground, so they will be flush with, or not more than 1/2 inch above, finish grade.

3.10 PIPING SCHEDULE

A. Install components having pressure rating equal to or greater than system operating pressure.

B. Piping in control-valve boxes and aboveground may be joined with flanges or unions instead of joints indicated.

C. Aboveground Irrigation Main Piping:

1. NPS 4 and Smaller:
   a. Galvanized-steel pipe and galvanized-steel pipe nipples; galvanized, gray-iron threaded fittings; and threaded joints.

D. Underground Irrigation Main Piping:
1. NPS 4 and Smaller:
   a. NPS 3 and NPS 4 ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings and gaskets; and gasketed joints.
   b. Schedule 40, PVC pipe and socket fittings, and solvent-cemented joints.

E. Circuit Piping:
1. NPS 2 and Smaller:
   a. SIDR 7 or SIDR 9, PE, controlled ID pipe; insert fittings for PE pipe; and fastener joints.
   b. Schedule 40, PVC pipe and socket fittings; and solvent-cemented joints.

F. Underground Branches and Offsets at Sprinklers and Devices: Schedule 80, PVC pipe; threaded PVC fittings; and threaded joints.
1. Option: Plastic swing-joint assemblies, with offsets for flexible joints, manufactured for this application.

G. Risers to Aboveground Sprinklers and Specialties:
   1. Schedule 80, PVC pipe and socket fittings; and solvent-cemented joints.

H. Drain piping shall be one of the following:
   1. SIDR 9, 11.5, or 15; PE, controlled ID pipe; insert fittings for PE pipe; and banded or fastener joints.
   2. Schedule 40, PVC pipe and socket fittings; and solvent-cemented joints.

3.11 VALVE SCHEDULE

A. Underground, Shutoff-Duty Valves: Use the following:
   1. NPS 2 and Smaller: Curb valve, curb-valve casing, and shutoff rod.
   2. NPS 3 and Larger: Iron gate valve, resilient seated; iron gate valve casing; and operating wrench(es).

B. Drain Valves:
   1. NPS 1/2 and NPS 3/4:
      a. Brass or bronze ball valve.
   2. NPS 1 to NPS 2:
      a. Brass or bronze ball valve.

END OF SECTION

SECTION 32 91 13

SOIL PREPARATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes planting soils specified by composition of the mixes.

B. Related Requirements:
   1. Section 31 11 00 "Clearing and Grubbing" for topsoil stripping and stockpiling.

1.2 DEFINITIONS

A. Duff Layer: A surface layer of soil, typical of forested areas, that is composed of mostly decayed leaves, twigs, and detritus.

B. Imported Soil: Soil that is transported to Project site for use.

C. Manufactured Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.

D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified as specified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

E. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

F. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

G. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil"; but in disturbed areas such as urban environments, the surface soil can be subsoil.

H. USCC: U.S. Composting Council.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each bulk-supplied material in sealed containers labeled with content, source, and date obtained; providing an accurate representation of composition, color, and texture.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent, state-operated, or university-operated laboratory; experienced in soil science, soil testing, and plant nutrition; with the experience and capability to conduct the testing indicated; and that specializes in types of tests to be performed.

PART 2 - PRODUCTS

2.1 PLANTING SOILS SPECIFIED BY COMPOSITION

A. Planting-Soil Type: Existing, on-site surface soil, with the duff layer, if any, retained; and stockpiled on-site; modified to produce viable planting soil. Blend existing, on-site surface soil with the following soil amendments and fertilizers in the following quantities to produce planting soil:
   1. Ratio of Loose Compost to Soil: 1:3 by volume.

B. Planting-Soil Type: Imported, naturally formed soil from off-site sources and consisting of sandy loam or loam soil according to USDA textures; and modified to produce viable planting soil.
   1. Sources: Take imported, unamended soil from sources that are naturally well-drained sites where topsoil occurs at least 4 inches deep, not from bogs, or marshes; and that do not contain undesirable organisms; disease-causing plant pathogens; or obnoxious weeds and invasive plants including, but not limited to, quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and bromegrass.
   2. Additional Properties of Imported Soil before Amending: Soil reaction of pH 5.5 to 7 and minimum of 6 percent organic-matter content, friable, and with sufficient structure to give good tilth and aeration.
   3. Unacceptable Properties: Clean soil of the following:
      a. Unacceptable Materials: Concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
      b. Unsuitable Materials: Stones, roots, plants, sod, clay lumps, and pockets of coarse sand that exceed a combined maximum of 8 percent by dry weight of the imported soil.
      c. Large Materials: Stones, clods, roots, clay lumps, and pockets of coarse sand exceeding 1 inch in any dimension.

   4. Amended Soil Composition: Blend imported, unamended soil with the following soil amendments and fertilizers in the following quantities to produce planting soil:
      a. Ratio of Loose Compost to Soil: 1:3 by volume.

C. Planting-Soil Type: Manufactured soil consisting of manufacturer's basic topsoil blended in a manufacturing facility with sand, stabilized organic soil amendments, and other materials to produce viable planting soil.
   1. Additional Properties of Manufacturer's Basic Soil before Amending: Soil reaction of pH 5.5 to 7 and minimum of 6 percent organic-matter content, friable, and with sufficient structure to give good tilth and aeration.
   2. Unacceptable Properties: Manufactured soil shall not contain the following:
      a. Unacceptable Materials: Concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
      b. Unsuitable Materials: Stones, roots, plants, sod, clay lumps, and pockets of coarse sand that exceed a combined maximum of 5 percent by dry weight of the manufactured soil.
      c. Large Materials: Stones, clods, roots, clay lumps, and pockets of coarse sand exceeding 1 inch in any dimension.

   3. Blend manufacturer's basic soil with the following soil amendments and fertilizers in the following quantities to produce planting soil:
      a. Ratio of Loose Compost to Soil: 1:3 by volume.

2.2 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter produced by composting feedstock, and bearing USCC's "Seal of Testing Assurance," and as follows:
   1. Feedstock: May include animal waste.
   2. Reaction: pH of 5.5 to 8.
   3. Soluble-Salt Concentration: Less than 4 dS/m.
   4. Moisture Content: 35 to 55 percent by weight.
   5. Organic-Matter Content: 50 to 60 percent of dry weight.
   6. Particle Size: Minimum of 98 percent passing through a 1-inch sieve.

B. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, debris, and material harmful to plant growth.

2.3 FERTILIZERS

A. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

B. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
   1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.

C. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.

PART 3 - EXECUTION

3.1 GENERAL

A. Place planting soil and fertilizers according to requirements in other Specification Sections.

B. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in planting soil.

3.2 PREPARATION OF UNAMENDED, ON-SITE SOIL BEFORE AMENDING

A. Excavation: Excavate soil from designated area(s) to a depth of 6 inches stockpile until amended.

B. Unacceptable Materials: Clean soil of concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.

C. Unsuitable Materials: Clean soil to contain a maximum of 8 percent by dry weight of stones, roots, plants, sod, clay lumps, and pockets of coarse sand.

D. Screening: Pass unamended soil through a 2-inch sieve to remove large materials.

3.3 PLACING AND MIXING PLANTING SOIL OVER EXPOSED SUBGRADE

A. General: Apply and mix unamended soil with amendments on-site to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Subgrade Preparation: Till subgrade to a minimum depth of 12 inches. Remove stones larger than 2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

C. Mixing: Spread unamended soil to total depth of 6 inches but not less than required to meet finish grades after mixing with amendments and natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.
   1. Amendments: Apply soil amendments and fertilizer, if required, evenly on surface, and thoroughly blend them with unamended soil to produce planting soil.
   2. Lifts: Apply and mix unamended soil and amendments in lifts not exceeding 8 inches in loose depth for material compacted by compaction equipment, and not more than 6 inches in loose depth for material compacted by hand-operated tampers.

D. Compaction: Compact each blended lift of planting soil to 90 percent of maximum Standard Proctor density according to ASTM D698 and tested in-place except where a different compaction value is indicated on Drawings.

E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.4 PLACING MANUFACTURED PLANTING SOIL OVER EXPOSED SUBGRADE

A. General: Apply manufactured soil on-site in its final, blended condition. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Subgrade Preparation: Till subgrade to a minimum depth of 12 inches. Remove stones larger than 1-1/2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

C. Application: Spread planting soil to total depth of 6 inches, but not less than required to meet finish grades after natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.

1. Lifts: Apply planting soil in lifts not exceeding 8 inches in loose depth for material compacted by compaction equipment, and not more than 6 inches in loose depth for material compacted by hand-operated tampers.

D. Compaction: Compact each lift of planting soil to 90 percent of maximum Standard Proctor density according to ASTM D698 except where a different compaction value is indicated on Drawings.

E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform the following tests and inspections:

1. Compaction: Test planting-soil compaction after placing each lift and at completion using a densitometer or soil-compaction meter calibrated to a reference test value based on laboratory testing according to ASTM D698. Space tests at no less than one for each 1000 sq. ft. of in-place soil or part thereof.

C. Soil will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Label each sample and test report with the date, location keyed to a site plan or other location system, visible conditions when and where sample was taken, and sampling depth.

3.6 PROTECTION AND CLEANING

A. Protection Zone: Identify protection zones according to Section 01 56 39 "Temporary Tree and Plant Protection."

B. Protect areas of in-place soil from additional compaction, disturbance, and contamination. Prohibit the following practices within these areas except as required to perform planting operations:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Vehicle traffic.
4. Foot traffic.
5. Erection of sheds or structures.
6. Impoundment of water.
7. Excavation or other digging unless otherwise indicated.

C. Remove surplus soil and waste material including excess subsoil, unsuitable materials, trash, and debris and legally dispose of them off Owner's property unless otherwise indicated.

1. Dispose of excess subsoil and unsuitable materials on-site where directed by Owner.

END OF SECTION

SECTION 32 92 00

TURF AND GRASSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Sodding.

1.2 DEFINITIONS

A. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

B. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 32 91 13 "Soil Preparation" and drawing designations for planting soils.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 INFORMATIONAL SUBMITTALS

A. Certification of grass seed.
   1. Certification of each seed mixture for turfgrass sod and seed.

B. Product certificates.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful turf establishment.
   1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
   2. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the National Association of Landscape Professionals:
      a. Landscape Industry Certified Technician - Exterior.
      b. Landscape Industry Certified Lawn Care Manager.
      c. Landscape Industry Certified Lawn Care Technician.
   3. Pesticide Applicator: State licensed, commercial.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" sections in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod within 24 hours of harvesting and in time for planting promptly. Protect sod from breakage and drying.

1.7 MAINTENANCE SERVICE

A. Provide full maintenance service by skilled workers employed by landscape installer. Maintain as specified in Part 3. Begin maintenance immediately following installation and continuing a minimum of 60 days. Continued maintenance of 60 calendar days shall continue past substantial completion and shall start when all landscape planting is accepted by the Landscape Architect.
   1. If initial maintenance period has not elapsed before end of planting season landscaper is responsible for maintenance until the next planting season.

1.8 WARRANTY

A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner.
   2. Warranty Periods: From date of Substantial Completion.
      a. Sod: 12 months.
      b. Seed: 12 months.

PART 2 - PRODUCTS

2.1 TURFGRASS SOD

A. Turfgrass Sod: Approved, complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture that is strongly rooted and capable of vigorous growth and development when planted.

B. Turfgrass Species: Sod of grass species as follows:
   1. Bluegrass mix, well rooted, minimum 1 year old.

2.2 SEED MIX

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA’s “Rules for Testing Seeds” for purity and germination tolerances.

B. Seed Species: Blue Grass Blend, by approval.
   1. Quality, State Certified: State-certified seed of grass species.

2.3 FERTILIZERS

A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
   1. Composition: 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.

B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
   1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.

2.4 PESTICIDES

A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

PART 3 - EXECUTION

3.1 TURF AREA PREPARATION

A. General: Prepare planting area for soil placement and mix planting soil according to Section 32 91 13 "Soil Preparation."

B. Reduce elevation of planting soil to allow for soil thickness of sod.

C. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

D. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.2 SODDING

A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.

B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to soil or sod during installation. Tamp and roll lightly to ensure contact with soil, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
   1. Lay sod across slopes exceeding 1:3.

C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

3.3 TURF MAINTENANCE

A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

B. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings.

3.4 HYDROSEEDING

A. Hydroseeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application. Slopes more than 4 horizontal to 1 vertical shall be hydroseeded.

B. Apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that much component is deposited at not less than 1500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate.

3.5 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Architect:
   1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.
   2. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.

B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

END OF SECTION

SECTION 32 93 00

PLANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Plant materials.
2. Fertilizers.
3. Weed-control barriers.
4. Mulches.
5. Herbicides and pesticides.
6. Tree stabilizing materials.
7. Landscape edgings.
8. Tree-watering devices.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product data, including soils.

B. Samples of each type of mulch, labeled with source in sealed plastic bag.

1.4 INFORMATIONAL SUBMITTALS

A. Product certificates.

B. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of plants.
1. Installer's Field Supervision: Maintain an experienced full-time supervisor on Project site when work is in progress.
2. Pesticide Applicator: State licensed, commercial.

B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver bare-root stock plants within 24 hours of digging. Immediately after digging up bare-root stock, pack root system in wet straw, hay, or other suitable material to keep root system moist until planting. Transport in covered, temperature-controlled vehicles, and keep plants cool and protected from sun and wind at all times.

B. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.

C. Handle planting stock by root ball.

D. Store bulbs, corms, and tubers in a dry place at 60 to 65 deg F until planting.

E. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.

1.8 WARRANTY

A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner.
      b. Structural failures, including plantings falling or blowing over.
   2. Warranty Periods: From date of Substantial Completion.
      a. Trees, Shrubs, Vines, and Ornamental Grasses: 12 months.
      b. Ground Covers, Biennials, Perennials, and Other Plants: 12 months.
      c. Annuals: Three months.

1.9 MAINTENANCE SERVICE

A. Provide full maintenance service by skilled workers employed by landscape installer. Maintain as specified in Part 3. Begin maintenance immediately following installation and continuing a minimum of 60 days. Continued maintenance of 60 calendar days shall continue past substantial completion and shall start when all landscape planting is accepted by the Landscape Architect.
   1. If initial maintenance period has not elapsed before end of planting season landscaper is responsible for maintenance until the next planting season.

PART 2 - PRODUCTS

2.1 PLANT MATERIALS

A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant List, Plant Schedule, or Plant call outs indicated on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

B. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which begins at root flare in accordance with ANSI Z60.1.

C. Annuals and Biennials: Provide healthy, disease-free plants of species and variety shown or listed, with well-established root systems reaching to sides of the container to maintain a firm ball, but not with excessive root growth encircling the container. Provide only plants that are acclimated to outdoor conditions before delivery.

2.2 FERTILIZERS

A. Plant Tablets: Commercial-grade, slow release, long-lasting planting fertilizer applied according to manufacturer's specifications.
   1. Products
      a. Agriform 20-10-5 or approved equal.

2.3 WEED-CONTROL BARRIERS

A. Composite Fabric: Woven, needle-punched polypropylene substrate bonded to a nonwoven polypropylene fabric, 5 oz./sq. yd.

2.4 MULCHES

A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:
   1. Type: Refer to Material Schedule on Drawings.
   2. Size Range: 3 inches maximum, 1/2 inch minimum.
   3. Color: Refer to Material Schedule on Drawings.

B. Mineral Mulch: Hard, durable stone, washed free of loam, sand, clay, and other foreign substances, of the following type, size range, and color:
   1. Type: Refer to Material Schedule on Drawings.
   2. Size Range: Refer to Material Schedule on Drawings.
   3. Color: Refer to Material Schedule on Drawings.

2.5 HERBICIDES AND PESTICIDES

A. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

B. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

C. Pesticides: Registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended in writing by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

2.6 TREE-STABILIZATION MATERIALS

A. Trunk-Stabilization Materials:

1. Upright and Guy Stakes: Rough-sawn, sound, new hardwood or softwood with specified wood pressure-preservative treatment, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal by length indicated, pointed at one end.
2. Flexible Ties: Wide rubber or elastic bands or straps of length required to reach stakes or compression springs.

2.7 LANDSCAPE EDGINGS

A. Concrete Mow Strip
1. Extruded Concrete
   a. 3,000 psi minimum compressive strength.
   b. Follow manufacture requirements mix design.
2. Formed Concrete
   a. 3,000 psi minimum compressive strength.
   b. 2.5” min. slump.
   c. Refer to Section 32 13 13 – Concrete for Exterior Improvements.

PART 3 - EXECUTION

3.1 PLANTING AREA ESTABLISHMENT

A. General: Prepare planting area for soil placement and mix planting soil in accordance with Section 32 91 13 "Soil Preparation."

B. Placing Planting Soil: Place manufactured planting soil over exposed subgrade or blend planting soil in place.

C. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.2 EXCAVATION FOR TREES AND SHRUBS

A. Planting Pits and Trenches: Excavate circular planting pits.
   1. Excavate planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are unacceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.
   2. Excavate approximately three times as wide as ball diameter for balled and burlapped or container-grown stock.
   3. Excavate at least 12 inches wider than root spread and deep enough to accommodate vertical roots for bare-root stock.
   4. Do not excavate deeper than depth of root ball, measured from the root flare to the bottom of root ball.

B. Backfill Soil: Subsoil and topsoil removed from excavations may be used as backfill soil unless otherwise indicated.

3.3 TREE, SHRUB, AND VINE PLANTING

A. Inspection: At time of planting, verify that root flare is visible at top of root ball in accordance with ANSI Z60.1. If root flare is not visible, remove soil in a level manner from root ball to where the top-most root emerges from the trunk. After soil removal to expose root flare, verify that root ball still meets size requirements.

B. Roots: Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

C. Balled and Burlapped Stock: Set each plant plumb and in center of planting pit or trench with root flare 1 inch above adjacent finish grades.
   1. Backfill: Planting soil for trees, use excavated soil for backfill.
   2. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
   3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
   4. Place fertilizer tablets according to the manufacturer's recommendations when pit is approximately one-half filled.
   5. Continue backfilling process. Water again after placing and tamping final layer of soil.

D. Container-Grown Stock: Set each plant plumb and in center of planting pit or trench with root flare 1 inch above adjacent finish grades.
   1. Backfill: Planting soil for trees, use excavated soil for backfill.
   2. Carefully remove root ball from container without damaging root ball or plant.
   3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
   4. Place fertilizer tablets according to the manufacturer's recommendations when pit is approximately one-half filled.

5. Continue backfilling process. Water again after placing and tamping final layer of soil.

E. Bare-Root Stock: Set and support each plant in center of planting pit or trench with root flare 1 inch above adjacent finish grade.
1. Backfill: Planting soil for trees, use excavated soil for backfill.
2. Spread roots without tangling or turning toward surface. Plumb before backfilling, and maintain plumb while working.
3. Carefully work backfill in layers around roots by hand. Bring roots into close contact with the soil.
4. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
5. Place fertilizer tablets according to the manufacturer's recommendations when pit is approximately one-half filled.
6. Continue backfilling process. Water again after placing and tamping final layer of soil.

F. Slopes: When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of root ball.

3.4 TREE, SHRUB, AND VINE PRUNING

A. Prune, thin, and shape trees, shrubs, and vines in accordance with standard professional horticultural and arboricultural practices. Unless otherwise indicated by Architect, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.

3.5 GROUND COVER AND PLANT PLANTING

A. Set out and space ground cover and plants other than trees, shrubs, and vines as indicated on Drawings in even rows with triangular spacing.

B. Use planting soil for backfill.

C. Dig holes large enough to allow spreading of roots.

D. Work soil around roots to eliminate air pockets and leave slight saucer indentation around plants to hold water.

E. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

F. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.6 INSTALLATION OF MULCHES

A. Install weed-control barriers before mulching in accordance with manufacturer's written instructions. Completely cover area to be mulched, overlapping edges minimum of 6 inches, and secure seams with galvanized pins.

B. Mulch backfilled surfaces of planting areas and other areas indicated.
   1. Trees and Treelike Shrubs in Turf Areas: Apply organic, unless otherwise noted on drawings, mulch ring of 3-inch average thickness, with 24-inch radius around trunks or stems for deciduous trees and ¾ of the radius of tree drip line for evergreen trees contained by metal landscape edging. Do not create a mulch cone or place mulch within 3 inches of trunks or stems.
   2. Mineral Mulch in Planting Areas: Apply 3-inch average thickness of mineral mulch over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 3 inches of trunks or stems.

3.7 INSTALLATION OF LANDSCAPE EDGINGS

A. Steel Edging: Install steel edging where indicated in accordance with manufacturer's written instructions. Anchor with steel stakes spaced approximately 30 inches apart, driven below top elevation of edging.

3.8 APPLICATION OF HERBICIDES AND PESTICIDES

A. Pre-Emergent Herbicides (Selective and Nonselective): Apply to tree, shrub, and ground-cover areas in accordance with manufacturer's written instructions. Do not apply to seeded areas.

B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written instructions.

C. Apply pesticides and other chemical products and biological control agents according to authorities having jurisdiction and in accordance with manufacturer's written instructions. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

3.9 PLANT MAINTENANCE

A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings.

B. Fill in, as necessary, soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.

C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices when possible to minimize use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

3.10 CLEANING AND PROTECTION

A. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

END OF SECTION